Instruction Manual

VENNER ELECTRONICS LIMITED

KINGSTON BY-PASS NEW MALDEN SURREY 01-942 2442

A member of the Venner Group of Companies

PRESET COUNTER

TYPE TSA5545

696

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CIRCUIT DESCRIPTION SHEETS

	Ref.No.	No. of Sheets
Stop/Start Shapers type 66/310 (Drg. ES66/94)	CD66/310	2
Decade Ring Counter type 66/132 (Drg. ES66/78)	CD66/132	2
Gate,Control & Reset Circuit types 66/602 (Drg.ES66/77)	CD66/602	4
Decade Divider type 66/140 (Drg. ES66/36)	CD66/140	2
Power Supply type 66/210 (Drg. E66/98)	CD66/210	1
Double Decade type 66/100 (Drg. ES66/29)	CD66/100	2
Pulse Shaper type 66/301*(Drg. E68/9)	CD66/301	3
Oscillator type 66/512 (Drg. ES66/24)	CD66/512	2
Store Transfer,Overflow & Delay Output type 66/610 (Drg. E66/80)	CD66/610	3
Low Speed Counter with Store &Display type 55/110) (Drg. E66/38)	CD55/110	2

COMPONENTS LISTS

	Ref.No.	No. of Sheets
Circuit ES66/84 (TSA5545 Wiring Diagram)	CL.TSA5545	3
" ES66/94 (Stop/Start Shapers type 66/310)	CL.66/310	1
" ES66/78 (Decade Ring Counter type 66/132)	CL.66/132	1
" ES66/77 (Gate, Control & Reset Circuits type 66/602)	CL.66/602	2
" ES66/36 (Decade Divider type 66/140)	CL.66/140	1
" E66/98 (Power Supply type 66/210	CL.66/210	1
" ES66/29 (Double Decade type 66/100)	CL.66/100	1
" E68/9 (Pulse Shaper type 66/301)*	CL.66/301	2
" ES66/24 (Oscillator type 66/512)	CL.66/512	2
" E66/80 (Store Transfer, Overflow & Delay Output type 66/610)	CL.66/610	2
" E66/38 (Low Speed Counter with Store & Display type 55/110)	CL.55/110	1

ILLUSTRATIONS

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Gate, Control & Reset Circuits type 66/602	" /77
Decade Divider type 66/140	" /36
Power Supply type 66/210	E66/98
Double Decade type 66/100	ES66/29
Pulse Shaper type 66/301*	E68/ 9
Oscillator type 66/512	ES66/24
Store Transfer, Overflow & Delay Output type 66/610	E66/80
Low Speed Counter with Store & Display type 55/110	" /38

* Some instruments are fitted with pulse shaper board type 66/300 for which corresponding information is provided at the rear of the manual.

CIRCUIT DESCRIPTION SECTION

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CD66/710	2
CD66/732	2
CD66/60Z	4
CD66/71O	2
CD66/720	1
CD66/74O	2
CD66/901	3
CD66/912	2
CD55/710	2

CIRCUIT DIAGRAMS LISTS

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" 66/710 (Step/Start Shapers type 66/710)	CL.66/732	1
" 66/732 (Decade Ring Counter type 66/732)		
" 66/602 (Gate, Control & Reset Circuits type 66/602)	CL.66/60Z	2
" 66/71O (Decade Divider type 66/71O)	CL.66/71O	1
" 66/720 (Power Supply type 66/720	CL.66/720	1
" 66/740 (Double Decade type 66/740)	CL.66/740	1
" 66/701 (Pulse Shaper type 66/701)*	CL.66/701	2
" 66/712 (Oscillator type 66/712)	CL.66/712	2
" 66/910 (Store Transfer, Overflow & Delay Output type 66/910)	CL.66/910	2
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Gate, Control & Reset Circuits type 66/602	" /7Z
Decade Divider type 66/71O	" /7E
Power Supply type 66/720	78A/7D
Double Decade type 66/740	78C/7F
Pulse Shaper type 66/701*	78E/ 9
Oscillator type 66/712	78G/9A
Store Transfer, Overflow & Delay Output type 66/910	78G/9C
Low Speed Counter with Store & Display type 55/110	" /9E

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* Some instruments are fitted with Pulse Shaper board type 66/700 for which corresponding information is provided at the rear of the manual.

1. INTRODUCTION

This instrument is basically a versatile five-digit variable time base frequency meter. In addition to the Count function, the instrument carries facilities for the measurement of Frequency and Frequency Ratio, Period measurement (by single or multi period sampling), Time interval measurement, and for the generation of accurate time delays.

The digital time base is fully variable over five digits and may be set to provide gating times between 1μs and 100 seconds. This facility enables the unit to be preset for the results of measurements to be displayed in certain engineering units as may be required (e.g. revolutions per minute).

The display is presented by five in-line end-view neon digital indicator tubes mounted behind a Polaroid screen; overflow and gating indication lamps are included. The display time may be varied and one measurement may be stored and displayed while another is accumulated: use of the latter facility is selectable at a two-position switch.

The instrument employs an oven-controlled 2MHz high stability crystal oscillator as internal reference source. Sensitivity, slope and trigger-level controls are incorporated, and auxiliary connections are provided at the rear panel. Outputs for data logging equipment are available as an optional extra.

Silicon semi-conductor devices are used throughout the instrument which is essentially of plug-in printed circuit design and is encased by a P.V.C. covered dual sectioned wrap. The unit is fitted with a swivelling carrying handle which may be locked in position to form a tilt stand.

2. SPECIFICATION

2.1 POWER SUPPLY

100 - 125 V, 40 - 60 Hz, or

200 - 250 V, 40 - 60 Hz

(For mains voltage selection see Section 3.1)

Consumption : approx. 35 W.

2.2 SIGNAL INPUTS

2.2.1 Inputs Freq. 'A' & 'B' (identical), a.c-coupled.

Frequency Range : 10 Hz to 2MHz,

Min. Amplitude : 75 mV r.m.s.

Max. Amplitude : 250V r.m.s.

Pulse Response : The instrument is triggered by positive-going signals of amplitude greater than 75 mV.

Paired Pulse resolution : 0.2μs (i.e. with pulse width of 0.1μs, pulse-spacing 0.1 μs).

Input Impedance (min.) : 250 kΩ shunted by 40 pF.

2.2.2 Start/Stop Inputs 'C' & 'D' (identical).

N.B. The inputs are a.c.- coupled.

Frequency range : 10 Hz to 100 KHz

Trigger Signal:-

(i) Manual depression of push-button

(ii) Pulse:-

Slope: Positive or Negative

Trigger Level: Adjustable between +3V & -3V
Amplitude: 0.5V to 50V peak.
Input Impedance: greater than 20 kΩ

(iii) Contact operation (of normally-closed or normally open contacts).

Note A switch-selectable filter facilitates contact bounce suppression: with the switch set to 'IN' inputs C & D are inhibited for approximately 3 ms after receipt of a signal. This time is preset to 3 ms but may be adjusted over the range 0.5 to 4 ms.

2.3 PRESETTABLE COUNT 'n'

Presettable from 1 to 10^5 in unit steps.

2.4 SELECTABLE TIME UNIT 't'

1 μs, 10 μs, 100 μs, or 1 ms.

2.5 B-SIGNAL-FREQUENCY-DIVISION -FACTOR (Selectable)

1, 10 , 10^2, 10^3

2.6 FREQUENCY MEASUREMENT

Function: Signals received at input 'Freq.A' counted for duration n x t

Accuracy: ± 1 count ± crystal stability (See Section 2.14)

2.7 PERIOD MEASUREMENT

Function : selected time signals counted over n periods of signal received at input 'Freq.A'

Accuracy : As for Frequency measurement $\pm$ Trigger level error.

Trigger level Error:-

With input signals of low frequency and near-minimum amplitude (75 mV) the error is as follows:

n = 1 : $\pm$ 0.3%

n = 10 : $\pm$ 0.03%

Error decreases by factor of 10 as n is raised by power of 10 (e.g. $n = 10^2$; error is $\pm$ 0.003%)

The accuracy improves rapidly with increase in signal amplitude.

2.8 TIME MEASUREMENT

Function : Selected time signals counted from receipt of Start signal at input 'C' to receipt of Stop signal at input 'D'.

Accuracy : $^{+0}_{-1}$ µs $^{+0}_{-1}$ time unit $\pm$ crystal stability (see section 2.14).

2.9 DELAY

i. (C→nt)

Function: leading-edge of 'Output' pulse occurs up to 1 µs after receipt of Start signal at input 'C'; the pulse width (or delay period) is n x t.

Accuracy of Pulse-width: dependent upon crystal stability (see Section 2.14).

ii. (C n/B)

Function: leading-edge of 'Output' pulse occurs up to 1 B-input-signal period after receipt of Start signal at input C; the pulse width (or delay period) is:-

n x period of signals received at 'Freq.B'input x setting of 'B Frequency Divider' switch.

Accuracy of pulse width: dependent upon 'Freq B' input signals.

2.10 RATIO MEASUREMENT

i. (nA/B)

Function: Signals received at input 'Freq A' counted for duration:-

n x period of signals received at input 'Freq B' x setting of 'B Frequency Divider' switch.

ii. nB/A

Function: Signals received at input 'Freq B' ÷ 'Frequency Divider' setting, counted for duration:-
n x period of signals received at input 'Freq.A'.

2.11 COUNT

Function: Signals at intervals equal to:-
the period of B-input signals x setting of 'B Frequency Divivder' switch ---- are counted after receipt of Start signal at input C up to receipt of Stop signal at input D.

Accuracy: $^{+0}_{-1}$ period of B signal $^{+0}_{-1}$ (period of B signal x setting of 'B Frequency Divider').

2.12 OUTPUTS:- 'Delay' & 2MHz - TEST'

Delay Output:

Waveform: Positive pulse (swing 0V $^{+0.5V}_{-0V}$ to +6V $^{-0.5V}_{+0V}$)

Rise & Fall Time : not greater than 40ns

Output Impedance : 50Ω

2MHz - Test Output:

Frequency : 2MHz

Signal Amplitude : Approx. 4V peak to peak

Waveform : Sinusoidal

Output Impedance : 1kΩ

2.13 DISPLAY

Display: Five digits displayed by in-line end-view cold cathode indicator tubes.

Display storage facility:-

'STORE': Readout retained until end of new sampling period.

Display Time:

Display setting 'FREE':-

Adjustable between approx. 0.5 and 5 seconds.

On timer setting 'INF' (infinity), display is retained until Reset Zero push-button is momentarily depressed (reset action may also be triggered remotely: See Section 2.16).

Display setting 'STORE':-

Display shown is result held in the store. Operation of Display Timer or Reset Zero push-button(or a reset signal)resets main counter but stored result remains displayed until, upon gate closure at end of new sampling period, display changes to show new result.

2.14 INTERNAL REFERENCE SOURCE

2MHz oven controlled crystal oscillator

Crystal stability : $\pm$1 part in 10^6

2.15 START CONTROL

When this input is held at the 'stop level' normal instrument-operation is inhibited (i.e. operation of main gate, pulse shaper etc. is inhibited). When the 'start level' is present the instrument is free to perform the selected function.

Start Level : 0V (i.e. socket centre-pin connected to outer shell, or when centre pin is open circuit.

Stop Level : +6V (with respect to chassis)

2.16 START 'C' & STOP 'D' SHAPER OUTPUTS

N.B. For inputs see Section 2.2.2

Waveform : Negative pulse (+ 6V $\begin{smallmatrix}+\\-\end{smallmatrix}$ $\begin{smallmatrix}0V\\0.5V\end{smallmatrix}$ to 0V $\begin{smallmatrix}+0.5V\\-0V\end{smallmatrix}$)

Falltime : Not greater than 50 ns

Pulse Width : approx. 1 μs

Output Impedance : 600 Ω

21 EXTERNAL RESET FACILITIES

Reset action (as produced by depression of Reset Zero push-button) is initiated when:-

(i) (Contact Reset) Rear-mounted sockets marked 'Contact Reset' are momentarily connected together externally. Minimum contact time : 20 ms.

or (ii) (Pulse Reset) A suitable pulse is applied to the rear-mounted 'Pulse Reset' socket.

Pulse : Negative-going (swing 1V to 20V max.)

Fall Time : Not greater than 0.1 μs

Pulse width : greater than 0.1 μs

Input Impedance : approx. 5.6 kΩ

2.18 DATA LOGGING FACILITY (Optional Extra)

4 lines or 8 lines per digit, plus 1 control line.

Code : 1-2-4-8 binary coded decimal

Outputs:-

	Output Impedance (approx.)	Min. Load Resistance	Open Circuit Levels+ (approx.) Std. 4-Line: Output (Socket A)	'Inverted' 4-Line Output (Socket B)
Digit Lines:	1kΩ	10kΩ	'1':+3.5V Min. '0':+0.5V Max.	+0.5V Max. +3.5V Min.
Print Command:	4kΩ	Signal:- 5V negative-going transistion (+5V to 0V) Signal returnsto +5V coincident with reset.		

+ With respect to chassis-earth.

2.19 TEMPERATURE RANGE

-10° to $+55^{\circ}$C

2.20 DIMENSIONS & WEIGHT (approx.)

Weight	Case Size:-		
	Width	Height	Depth (front to rear)
$16\frac{1}{2}$ lb.	$17\frac{1}{4}$ in.	$5\frac{1}{4}$ in.	$13\frac{1}{4}$ in.
(7.5 kg)	(43.8 cm)	(13.3 cm)	(33.6 cm)

3. OPERATING INSTRUCTIONS

3.1 MAINS-VOLTAGE SETTING

The mains transformer of the internal power unit has twin primary windings which may be series-connected for operation on supply voltages in the range 200 to 250V a.c., or parallel-connected for operation on supplies in the range 100 to 125V a.c.

The instrument is normally despatched set for 200 to 250V a.c. operation.

To select the other voltage-range first remove both sections of the case. To remove a section, withdraw the two 4 BA screws from either side, slide cover backwards sufficiently to disengage front-edge from panel surround, then lift away.

The plug-in power unit is situated adjacent to the rear panel: withdraw its three fixing screws (arranged in triangular formation around the cut-out on the underside of the chassis), disengage the flying-plug and remove the unit from the instrument.

The primary windings are terminated on that side of the transformer where the tags are arranged viz:-

Note: X represents tag

X 120 V - live input-line
X 0 V
X 120 V
X 0 V - neutral input-line
(base of power unit)

The 'live' and 'neutral' lines should remain connected as indicated above.

For 100 to 125V a.c. connect windings in parallel(i.e. link* 120V tags together and link* 0V tags together). For 200 to 250V a.c. connect windings in series (i.e.link* together the two inner tags).

Replace and secure the power unit, re-connect the flying-plug and secure the instrument case before connecting the supply.

* By means of a soldered wire

3.2 SUPPLY CONNECTION

With mains transformer appropriately connected (see above section), and Power switch in the OFF position, connect 3-core mains cable to supply as follows.

Brown*	(Red) core	:	mains live
Blue*	(Black) core	:	mains neutral
Green/Yellow*	(Green) core	:	earth

3.3 TEST FACILITY

Note: Although measurements may be taken immediately after the supply has been switched ON, in order that the degree of accuracy achieved shall conform to the specification a period of at least 15 minutes should be allowed to elapse for temperature stabilization of the internal crystal oven.

The 2MHz Test Frequency output may be used to check the counting and readout operations of the instrument in the functions Frequency and Period: proceed as follows:-

i) Feed output of Test socket (2MHz) to A-input socket and set its Sensitivity control to 'MAX'.

ii) Set 't/FREQ B' switch to 't'.

iii) Set display storage switch to 'FREE'

iv) Set 'n' (i.e. in-line switch bank) initially to 00010 for Frequency test (later set to 10,000 for Period test).

v) Set rear-mounted NORMAL/RECYCLE switch to 'NORMAL'.

NB. Display Time switch may be set either to 'INF' (each new count is then initiated upon momentary depression of Reset push-button) or to 'MAX', for which measurements will occur automatically (duration of display being dependent upon setting of Display Timer).

Below are listed, for each setting of the 4-position 'Time Units t' switch, displays which should occur for the Frequency and Period positions of the function selector.

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* These core colours of the international code will supersede core colours shown bracketed and hitherto used on instruments type TSA5545. For an interim period either type of cable may be fitted.

Time Units t Switch Setting	Function Selector Setting Frequency	 Period
(Switch bank setting:-	n = 10	n = 10,000)
1μs	00020 ±1	05000 ±1
10μs	00200 ±1	00500 ±1
100μs	02000 ±1	00050 ±1
1ms	20000 ±1	00005 ±1

3.3 FREQUENCY FUNCTION

Measurement Procedure:-

(i) If Data logging output facility (optional extra) is to be used see Section 4.1 for connections.

(ii) With Power switch in 'ON' position set Display Timer as required. With control set to INFinity (i.e. anticlockwise limit) reset action is initiated upon momentary depression of Reset Zero push button or application of a reset input signal (for latter see Section 4.3). When control is switched from 'INF' setting reset action is triggered automatically, display time is then proportioned to control rotation: range approx. 5 sec. to 0.5 sec. (Min.).

(iii) Set Display switch as required.

'FREE': For each measurement the indicators show the progression and result of each count; set 'Normal/Recycle' switch* to 'Normal'.

'STORE' *+: Only the result of the count is displayed; it is retained until the end of the next gating period whereupon the new count is shown. See Section 4.5 to set 'Normal/Recycle' switch*.

NB. The gating lamp is extinguished at the end of each gating period, but no visible change will occur in the display should the new count be the same as the previous result. Gating and Overflow lamps are situated in the right and left lower corners of the display screen respectively. The Gating Lamp is illuminated for the duration of each counting period.

(iv) Connect signal lead to coaxial socket 'Freq. A' and appropriately set associated Sensitivity control.

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*+ On this setting, depression of the Reset Zero push-button (or a reset input signal) resets the counter circuit but the display remains unchanged.

* This switch is mounted on the rear panel.

(v) Select required gating time (nt) by setting 't/Freq.B' switch to 't', Time Units switch for appropriate period (1 μs, 10 μs, 100 μs, or 1 ms) and setting the bank of five in-line edge-wise switches to the required multiplying factor 'n'.

Example: With Time Units switch set to 10 μs and switch bank set to '00025' the gating time is 250 μs.

NOTE: When switch bank is set to '00000' the effective value of n is 10^5

(vi) With Function Selector set to Frequency A. nt, momentarily depress Reset Zero push-button[+] for a measurement to be initiated. On Display Timer settings other than INF measurements will hence-forth occur automatically. The resultant number displayed is the quantity of A-input cycles received during the gating time:

or Count = Freq. A x nt as marked in blue at Function Selector however, any overflow must be taken into account.

NOTE: Whether the count capacity of the instrument is exceeded during a measurement depends upon the input frequency and gating time employed.

On setting 'Display FREE' the Overflow indicator lamp (on left of display screen) is illuminated when overflow first occurs and remains ON until the instrument is reset.

Example: With an A-input frequency of 50 kHz and selected gating time (nt) of 3 seconds, the count capacity of the instrument would be exceeded once during the measurement (Overflow lamp would light) and a display of 50000 would be shown.
The overflow digit (most significant digit) '1' should then be appended to the displayed count to yield the complete count 150000.

[+] Or apply a reset signal: see Section 4.3

3.4 PERIOD

Measurement procedure:-

Carry out procedures (i) to (iv) of Section 3.3 then proceed as follows:-

(a) Set switch bank for required number (n) of A-signal periods to be timed.

NB. When switch bank is set to 'ooooo' the effective value of n is 10^5.

(b) Select a time unit suitable for the magnitude of the interval to be timed, by setting 't/Freq B' switch to 't' and appropriately setting Time Units switch.

(c) With Function Selector set to 'Period' momentarily depress Reset Zero push button[+]. for a measurement to be initiated. On Display Timer settings other than INF measurements will henceforth occur automatically. The resultant count = n/At as marked in blue at Function Selector and is the number of timing signals counted during gating time:- n x period of signal at input A.
Any overflow should be taken into account in the manner described in the Example under Frequency Function.

Trigger Level Error:

Results are subject to trigger level error which is manifested in repeated measurements by jitter of the least significant digit/s. The error is more pronounced with input signals of low frequency and near minimum amplitude (75mV): for such signals the error on the ranges is:-

n = 1 : ± 0.3%
n = 10 : ±0.03%

Error decreases by factor of 10 as n is raised by power of 10 (e.g. n = 10^2; error is ± 0.003%). The accuracy improves rapidly with increase in signal amplitude.

[+] Or apply a reset signal: see Section 4.3

3.5 TIME

Measurement Procedure:-

Carry out procedures (i) to (iii) of Section 3.3 then proceed as follows:-

(a) Select a time unit suitable for the magnitude of the interval to be timed, by setting 't/Freq B' switch to 't' and appropriately setting Time Units switch.

(b) With Function Selector set to 'Time', timing will ~~commence~~ between 0 and 1 μs after the application of a signal at input C and will cease upon application of a signal at input D: the signals may take one of the forms treated in (c) below. Select required form and proceed accordingly.

(c) Push-button Operation

Momentarily depress Reset Zero push-button+.

To start the gating time momentarily depress the Start push-button; to end it, momentarily depress the Stop push-button.

Pulse Input.

i) Connect input signal lines to C (start) and D (stop) terminals For each input, set the associated 4-position switch (i.e. to '+' if input circuit is to be triggered by positive-going signals; to '-' for operation by negative-going signals). Also set associated C & D potentiometers for required trigger levels (+ and- marks correspond to approximately +3V and -3V respectively).

NOTE: The outputs of the Start-C and Stop-D input pulse shapers are available for monitoring (see Section 4.2).

ii) Momentarily depress Reset Zero Push-button.+

+ Or apply a reset signal: see Section 4.3

iii) Apply Start signal[+] to C-input socket to commence gating time.

iv) Apply Stop signal[+] to D-input socket to end gating time.

N.B: Should instrument not respond to start and/or stop input signals, reduce setting of associated trigger level potentiometer/s and repeat procedures ii) to iv) above.

Contact Operation.

(i) For each input:- set the associated 4-position switch for the required form of contact operation (i.e. N/O if the signal is to be presented upon the closure of normally-open contacts; to N/C if the signal is to be presented upon the opening of normally-closed contacts) and connect the contacts between appropriate input sockets (i.e. C or D) and chassis-earth terminal[++]

(ii) Contact Bounce:

A facility is provided for contact-bounce suppression; it may be selected at the switch marked 'Contact Bounce Filter'. With the switch set to 'IN', the Start and Stop inputs (when set for contact operation N/C or N/O) are inhibited for approximately 3 ms after receipt of a signal.

Set Filter switch as required

NOTE: The Filter facility should be used in any arrangement of the Start/Stop contacts where contact bounce would cause an incorrect measurement, e.g. when the Start and Stop inputs are set to N/O and N/C respectively; linked together, and taken to chassis-earth via a pair of N/O contacts whose closed period is to be measured (refer Section 3.11'a') and where contact closure would commence the gating time but re-opening of the contacts (due to contact bounce) would prematurely end the gating time.

[+]For signal specification refer to Section 2.2.2

[++]Various connections for contact timing are given in Section 3.11.

(iii) Momentarily depress the Reset Zero push-button+

(iv) The gating period will commence upon operation of the start contact and end upon operation of the stop contact. Whether overflow will occur depends upon both the duration of the time interval and upon the selected time unit; any overflow should be taken into account (in the manner described in the 'Example' under Frequency Function) before multiplying by the selected time unit to obtain the complete time measurement. The count = (interval C→D) /t indicated in blue at Function Selector.

3.6 DELAY C →nt

On this function the leading-edge of the 'delay pulse', produced at the Output socket, occurs up to 1 μs after receipt of a start signal at input-C; the pulse width is the product nt as marked in blue at the Function Selector.

Procedure:-

Carry out procedures (i) to (iii) of section 3.3 then continue as follows:-

(a) With Function Selector set to 'Delay C→nt' select required time unit(t) by setting 't/Freq B' switch to 't' and appropriately setting the associated Time Unit switch.

(b) Set switch bank for required value of 'n'.

N.B. When switch bank is set to '00000' the effective value of n is 10^5; if this setting is used overflow will occur i.e. display will show all zeros with overflow lamp alight to indicate 10^5.

(c) Connect delay-signal lead to Output socket.

(d) The start signal applied at input C may take one of three forms, refer to Section 3.5 'c'.

(e) Having set the C-input controls as necessary, momentarily depress the Reset Zero push-button+: to initiate the delay period apply a start signal at input-C.

+ Or apply a reset signal: see Section 4.3

3.7 RATIO nA/B

Measurement Procedure:-

Carry out procedures (i) to (iv) of Section 3.3 then continue as follows:-

(a) Set Function Selector to Ratio nA/B and connect lead carrying signals for use as time-base, to Freq B socket. Adjust Freq B sensitivity control as required.

(b) Set 't/FreqB' switch to FreqB; set associated 'B Frequency Divider' to appropriate tens factor (1, 10, 10^2, or 10^3) and set switch bank for required value of 'n'. The gating period is given by:-

Period of B-signal x B Frequency Division factor x n.

N.B. When switch bank is set to '00000' effective value of n is 10^5.

(c) Momentarily depress Reset Zero push-button+.

(d) Any overflow should be taken into account (in the manner described in the 'Example' under Frequency Function).

$$\text{Count} = \frac{n\ A}{B}$$ (as marked in red at Function Selector)

Where: A is frequency applied at input Freq. A

B " " " " " Freq.B ÷B Frequency division factor

n is switch bank setting

3.8 RATIO n B/A

Measurement Procedure:-

Carry out procedures (i) to (iii) of Section 3.3 then continue as follows:-

---

+Or apply a reset signal: see Section 4.3

(a) Set Function Selector to Ratio nB/A and connect lead carrying signals for use as time-base, to Freq A socket ; set Freq A sensitivity control as required.

(b) Set switch bank for required value of 'n'. The gating period is given by:- n x period of A-signals.

N.B. When switch bank is set to 'ooooo' effective value of n is 10^5.

(c) Connect second signal-lead to Freq B socket ; set 't/Freq B switch to Freq.B and set associated 'B Frequency Divider' to required tens factor (1, 10, 10^2, or 10^3).

(d) Momentarily depress Reset Zero push-button.

(e) Any overflow should be taken into account (in the manner described in the 'Example' under Frequency Function).

$$\text{Count} = \frac{nB}{A} \text{ (as marked in red at Function Selector)}$$

Where: A is frequency applied at input Freq A

B " " " " " Freq B ÷B Frequency division factor

n is switch bank setting

3.9 COUNT B/C→D

Procedure:-

Carry out procedures (i) to (iii) of Section 3.3 then continue as follows:-

(a) Set Function Selector to Count B/C→D and connect signal lead to Freq B socket .

(b) The start and stop signals may take one of three forms, refer to Section 3.5 'c'

NOTE: The methods described in Section 3.11 for start/stop contact operation may be used also in this function to control counting (or 'timing' if the B-input signals are supplied by an external timing-signal source).

(c) Having set the C-input controls as necessary, momentarily depress the Reset Zero push-button.+

(d) To commence the gating period apply a start signal to input-C: to end the period apply a stop signal to input-D. Any overflow should be taken into account (in the manner described in the 'Example' under Frequency Function) when reading resultant display. Red marking at Function Selector indicates that B-signals are counted for the interval C ⟶ D.

3.10 Delay C → $^{n}/_{B}$

On this function the leading-edge of the 'delay pulse', produced at the Output socket, occurs up to one period of B input signal after receipt of a start signal at input-C; delay pulse width is the quotient n/B (where B is:- frequency at input Freq B ÷ B Frequency division factor) as marked in red at the Function Selector.

Procedure:-

Carry out procedures (i) to (iii) of Section 3.3 then continue as follows:-

(a) With Function Selector set to 'Delay C ⟶ $^{n}/_{B}$' connect the signal lead to Freq. B socket.

(b) Set 't/Freq B' switch to Freq. B; set associated 'B Frequency Divider' to required tens factor (1, 10, 10^2 or 10^3) and set switch bank for required value 'n'.

NB. When switch bank is set to '00000' effective value of n is 10^5: if this setting is used overflow will occur, i.e. display will show all zeros with overflow lamp alight to indicate 10^5.

(c) Connect delay-signal lead to output socket.

(d) The start signal applied to input C may take one of three forms, refer to Section 3.5 'c'.

+ Or apply a reset signal: see Section 4.3

(e) Having set the C-input controls as necessary, momentarily depress the Reset Zero push-button[+]: to initiate the delay period apply a start signal to input-C.

3.11 CONNECTIONS FOR CONTACT TIMING (On Function 'Time')

Methods for timing the operations of contacts in various arrangements are given below. For precise details of procedures refer to Section 3.5

(a) Closed-time of a pair of normally-open contacts:-

Set C-input switch to N/O and D-input switch to N/C.

Link sockets C and D together and connect the normally open contacts between this link and the chassis-earth terminal; see Footnote.

Timing will commence when the contacts close and will cease when they open.

(b) Open-time of a pair of normally-closed contacts:-

Set C-input switch to N/C and D-input switch to N/O.

Link sockets C and D together and connect the normally closed contacts between this link and the chassis-earth terminal.

See Footnote.

Timing will commence when the contacts open and will cease when they close.

[+]Or apply a reset signal: see Section 4.3

Footnote: The filter facility may be used (i.e. filter switch set to IN) for contact bounce suppression, providing that the interval to be timed will be greater than the input inhibit period (approx. 3 ms).

(c) Time between closure of a pair of normally-open contacts and closure of a second pair of normally-open contacts

The pair of contacts which upon closure is to start the timing operation should be connected between socket C and the chassis-earth terminal. Connect the second pair of contacts between socket D and the chassis-earth terminal.

Set C and D input switches to N/O.

See Footnote

Timing will commence when the first pair of contacts close and will cease upon closure of the second pair.

(d) Time between closure of a pair of normally open contacts and subsequent opening of a pair of normally closed contacts:-

Set C-input switch to N/O and D-input switch to N/C: See footnote.

Connect the pair of contacts N/O which are to be used to start the count, between socket C and chassis-earth terminal.

Connect the pair of contacts N/C which are to be used to stop the count, between socket D and chassis-earth terminal.

Timing will commence when the first pair of contacts close and will cease upon opening of the second pair of contacts.

(e) Time between opening of a pair of normally-closed contacts and opening of a second pair of normally-closed contacts:-

The pair of contacts which upon opening is to start the timing operation should be connected between socket C and the chassis-earth terminal, whilst the second pair should be connected between socket D and the chassis-earth terminal. Set C and D input switches to N/C. See footnote.

Timing will commence when the first pair of contacts (i.e. C-input contacts) open and will cease when the second pair open.

Footnote: The filter may be used (i.e. filter switch set to IN) for contact bounce suppression, providing that the interval to be timed will be greater than the input inhibit period (approx. 3 ms).

(f) Time between opening of a pair of normally-closed contacts and subsequent closing of a pair of normally-open contacts:-

Set C-input switch to N/C and D-input switch to N/O. See footnote.

Connect the normally-closed contacts between socket C and the chassis-earth terminal. Connect the normally-open contacts between socket D and the chassis-earth terminal.

Timing will commence when the normally-closed contacts open and will cease when the normally-open contacts close.

3.12. DELAY BETWEEN ENERGISATION & CONTACT-OPERATION OF A RELAY

The delay between relay energisation (or de-energisation) and operation of the associated contacts may be determined on function 'Time'.

The external energising supply, relay-solenoid and contacts should be arranged such that upon energisation (or de-energisation) the change in voltage across the solenoid is presented as a 'gate-opening signal' between socket C and the chassis-earth terminal (the C-input controls should be suitably set for pulse polarity and trigger level+) whilst operation of the contacts presents a 'gate-closing signal' between socket D and the chassis earth terminal (the D-input switch should be set to N/O or N/C as appropriate).

N.B. The C-input signals should conform to the specification of Section 2.2.2.

Footnote: The filter may be used (i.e. filter switch set to IN) for contact bounce suppression providing that the interval to be timed will be greater than the input inhibit period (approx.3 ms).

+Control setting is treated in Section 3.5

4. AUXILIARY FACILITIES

4.1 DATA LOGGING OUTPUT FACILITY (1-2-4-8 code)

This facility is an optional extra and is provided only if initially ordered. For instruments carrying this facility a suffix is added to the instrument type number engraved on the rear panel label: the suffix is indicated below.

A rear-mounted Amphenol 36-pin socket marked 'A' is fitted for standard 4-line per digit B.C.D. output (Suffix Z). An identical socket marked 'B' (carrying digit-outputs complementary to those of the latter socket) is fitted when 4-line per digit 'inverted' output is required (suffix Z1).

Both output sockets are fitted when 8-line per digit output is required (suffix Z2).

The signals are specified in Section 2.13: connections are as follows.

Pin No.	Sockets A & B	Pin No.	Sockets A & B
1	M.S.D. 1	19	4th M.S.D. 8
2	" 2	20	Unused
3	" 4	21	L.S.D. 1
4	" 8	22	" 2
5	Unused	23	" 4
6	2nd M.S.D. 1	24	" 8
7	" " 2	25	Unused
8	" " 4	26	"
9	" " 8	27	"
10	Unused	28	"
11	3rd M.S.D. 1	29	"
12	" " 2	30	"
13	" " 4	31	"
14	" " 8	32	"
15	Unused	33	Print Command O/P
16	4th M.S.D. 1	34	Chassis-earth
17	" " 2	35	Unused
18	" " 4	36	"

N.B. M.S.D. = Most significant digit
L.S.D. = Least " "

4.2. START-C OUTPUT & STOP-D OUTPUT.

The output of the Start-C and Stop-D input pulse shapers are available for monitoring at coaxial sockets on the rear panel.

The exact point on an input waveform at which the associated pulse shaper is triggered, may be determined by comparison of the input and output waveforms, of the shaper, when applied to the respective beams of a double beam oscilloscope.
To change the trigger point, use may be made of the associated variable trigger level control or Slope selector.
It is advisable to observe the shaper outputs in this manner whenever there is doubt regarding the validity of the displayed results for functions where inputs C and D are employed.

4.3. EXTERNAL RESET.

Reset may be initiated externally by means of a contact closure (see Section 2.17 'i') or by application of a pulse (see Section 2.17 'ii').

4.4 START CONTROL

A coaxial socket (BNC) marked 'Start Control' is fitted on the rear panel.

Whenever this input is held at OV (start level), or is left open circuit, the instrument is free to perform the selected function; when it is held at 6V (stop level) progression of the count (as displayed by the indicators) is interrupted, since the applied potential has the same function as an internal inhibit signal (i.e. operation of main gate, pulse shaper etc. is inhibited). The instrument is free to count once the control signal acquires the 'start level'.

For Start Control specifications see Section 2.15.

4.5 NORMAL/RECYCLE FACILITY

A two position slide-switch marked Normal/Recycle is fitted on the rear-panel. With the switch set to 'Normal' the duration of display is dependent upon the setting of the Display Timer as treated in Section 2.13.

When visual display is of secondary importance to that of gating and logging rate the switch should be set to 'Recycle', the Display Timer is then held inoperative and reset action occurs automatically when the count-information has been transferred to the store. The Recycling time (i.e. minimum inter-gating time) is approximately 25ms.

It is not recommended that the Recycle facility be used for gating periods less than approximately 5ms. The facility may not function for shorter gating periods since the time between consecutive gate-opening signals will be tending to the minimum necessary for recovery of the internal Inhibit monostable.

5. MAINTENANCE

CAUTION: Whenever the instrument is operated with the case removed, care should be exercised to ensure that no physical contact is made with exposed connections, particularly those of the mains circuit in the regions of the Power switch and power supply unit.

CASE REMOVAL: Each section of the case is secured by two 4 BA screws at each side.

To remove a section withdraw the four fixing screws, slide cover backwards sufficiently to disengage front-edge from panel surround, then raise.

5.1 FUSES & ADJUSTMENT OF PRESET D.C. SUPPLIES

The counter employs a power unit type 66/210 situated near the rear of the instrument. The power unit provides three d.c. supplies; $\pm$6V stabilized supplies for the transistor circuits and a +235V anode-supply for the neon indicator tubes.

The three d.c. supplies may be measured at pins of the chassis-mounted power unit inter-connecting socket (type B9A) accessible from the underside of the instrument after removal of the lower section of the case.

Should access to the power unit fuses and preset voltage controls be required during the following procedure remove the top section of the case; then remove the power unit cover-plate (secured by three cross-head screws) to reveal the fuses and controls which are mounted on the printed circuit board of the power unit thus:-

FS1	FS2	FS3	RV2	RV1
			(-6V	+6V)
			(voltage controls)	

To check and adjust the $\pm$6V supplies proceed as follows.

(CAUTION: Mains connections are present at pins 7 and 8 of the power unit socket).

i) +6V Connect a suitable voltmeter* between pin 9 (Negative) and pin 1 (Positive) of the power unit socket. The meter should indicate 6V: if necessary adjust RV1 for this value.

Note: In absence of supply, switch OFF mains and check mains input fuse (500mA Venner Part No. Z22867/2) at rear of instrument. If the latter is in order, check power unit fuses FS2 and FS3 (1.5A Venner Part No. Z26413/2).

ii) -6V Remove voltmeter and re-connect to the socket as follows. Positive lead to pin 9, Negative lead to pin 2. The meter should indicate 6V: if necessary adjust RV2 for this value.

Note: In absence of supply, switch OFF mains and check power unit fuses FS2 and FS3 (1.5A Venner Part No. Z26413/2).

iii) The functions of RV1 and RV2 are to some extent inter-dependent, therefore, should their settings have been altered, repeat procedures (i) and (ii) above until the required voltages are obtained without adjustment of controls.
Disconnect the voltmeter.

To check the +235V supply, connect a suitable voltmeter** to the power unit socket viz: Negative lead to pin 9, Positive lead to pin 3. The supply should be 235V $\pm$10% on-load (or approx. 270 $\pm$10% off-load). No control is provided for this supply since stabilization is not required.

Note: In absence of supply, switch OFF mains and check power unit fuse FS1 (100mA Venner Part No. Z26413/1).

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* Suitable voltmeter 'AVO' Model 8 set to 10V d.c. range

** " " " " " " " 250V d.c. "

5.2 ADJUSTMENT OF PRESET OSCILLATOR-TRIMMER

An oscillator trimmer-capacitor is mounted on the chassis near the right-hand corner: see layout diagram S65/39. The control is preset and in normal circumstances no adjustment should be necessary.

The oscillator Frequency (2 MHz) may be monitored at the front-panel-mounted '2 MHz Test' socket; the monitored frequency should be compared with signals from an appropriate external standard frequency source and the trimmer adjusted if necessary.

5.3 INDICATOR & PLUG-IN PRINTED-CIRCUIT-BOARD REPLACEMENT

The neon indicator tubes are wired to printed circuit plug-in counter/display boards; in the event of failure of an indicator, or of a fault having been traced to a plug-in circuit board, it is recommended that the board concerned be removed and returned to Venner Electronics Limited for rectification.

For each plug-in board, the finger-grip/spacer (fitted to top of board) and guide (fitted to rear panel) correspond in colour; thus for board re-insertion appropriate positions are readily discernible. Boards of one type bear the same colour. For board locations refer to diagram S65/39.

5.4 GATING & OVERFLOW LAMP REPLACEMENT

For access to these lamps proceed as follows:-

(i) Remove the top section of the instrument cover (refer to Section 5, 'Case Removal').

(ii) Withdraw the five counter/display boards type 55/110 (colour code light blue) see layout diagram S65/39.
Each lamp is held in a small clip and is connected by two leads. The termination points should be noted; the faulty lamp removed, and the replacement connected in position.
Replacement Neon Lamp: Venner Part No. Z50398. Re-insert counter/display boards and replace top section of the instrument cover.

Start and Stop Shapers type 66/310 (Drg. ES66/94)

The 66/310 board accomodates two identical shaper circuits, one operated by a 'start' signal, the other by a 'stop' signal. Such signals may be either squarewave or sinusoidal of amplitude in the range 0.5V to 50V*, and of a maximum frequency of 100KHz. For simplicity only the 'start' shaper circuit is here described:-

The 'start' signal enters at TP12 whence it passes to the amplifier VT1. Overloading is prevented by diode MR2. The trigger level of the circuit can be varied over the range -3V to +3V approx. by connecting TP16 via a 22kΩ resistor to the wiper of an external 1kΩ potentiometer connected across the +6V and -6V supply lines.

The signal from VT1 drives the Schmitt Trigger VT2 & VT3. The inverter stage VT4 gives an output in antiphase to that of VT3, and each of these outputs passes via a differentiator (C6 & R18, C7 & R17) to a gated amplifier (VT9, VT11) and also to an input gating diode (MR5, MR6) of the monostable multivibrator VT5 & VT6.

The states of transistors VT8 and VT10 follow that of VT5. Therefore, when the multivibrator is in the stable state, i.e. when VT5 is conducting, VT8 and VT10 are also conducting, causing VT9 and VT11 to act as grounded-emitter amplifiers. When, however, the multivibrator is in the unstable state, VT8 and VT10 are switched off, rendering VT9 and VT11 inoperative.

Alternatively the circuit may be operated by the opening or closing of a pair of contacts connected externally between TP's 16 and 14, provided that TP16 is connected to +6V supply line via a suitable resistor (e.g. 22kΩ), so that VT1 is normally 'on' for normally open contacts, and 'off' for normally-closed contacts.

* Peak value

In operation by such a pair of contacts, spurious output pulses may result from contact "bounce". These pulses are inhibited by the CONTACT BOUNCE FILTER (operative when TP9 is unconnected), which acts as follows:-

On closure of the contacts, VT1 is switched off and there is produced simultaneously a narrow negative pulse at MR6 cathode and a narrow positive pulse at MR5 cathode. The former pulse triggers the multivibrator while the latter is inverted by VT9 to appear at output TP10. Since VT11 is normally non-conductive it is not affected by the negative pulse from C7. Immediately after the multivibrator has been triggered into the unstable state VT8 and VT10 switch off, so that no further output pulses can emerge during the period of the unstable state. Conversely, if the contacts are initially closed, a single narrow negative pulse occurs at output TP11 and repeated switching of VT1 during the multivibrator unstable state period produces no additional output pulses. This period can be varied within the range 0.5 to 5ms approximately by adjustment of RV1; it is normally preset to 3ms.

The CONTACT BOUNCE FILTER can be rendered inoperative by connecting TP9 to the OV line, so that VT5 is made insensitive to trigger pulses. In such a case, all positive-going and negative-going voltage changes that switch the Schmitt Trigger (whether via TP12 or TP16) produce negative pulses at TP11 and TP10 respectively.

Decade Ring Counter type 66/132 (Drg.ES66/78)

A high input impedance is presented, to signals applied at TP* 'R', by emitter follower VT1 which employs resistor R80 as parasitic suppressor. The emitter of VT1 is connected to the main signal line of the scale-of-ten twisted ring counter comprising five bi-stables VT2-11.

The counter is in the zero condition when the even-numbered transistors VT2,4,6,8 & 10 are conductive, and is triggered by negative-going signals applied at TP 'R'.

The table below indicates the states of the bi-stables for each count condition.

(NB. For Bi-stable state '0' even-numbered transistor is conductive)
" " " '1' odd-numbered " " ")

Bi-stable:-		VT2-3	VT4-5	VT6-7	VT8-9	VT10-11
Condition	0	0	0	0	0	0
"	1	1	0	0	0	0
"	2	1	1	0	0	0
"	3	1	1	1	0	0
"	4	1	1	1	1	0
"	5	1	1	1	1	1
"	6	0	1	1	1	1
"	7	0	0	1	1	1
"	8	0	0	0	1	1
"	9	0	0	0	0	1

A negative-going carry signal is produced at TP 'P' as the counter is triggered from the 9 to the zero condition.

The count information is available at termination points N-J,9-13 which are connected to the collectors of transistors VT2-11: i.e. collectors 1 to 10 as marked on diagram.

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* TP = Termination point

The waveforms at the decade collectors are such that a positive-going edge occurs at collectors 1-10 in turn as the 1st to 10th input pulses are received; whilst negative-going edges occur in turn at collectors 6-10 and 1-5 for the 1st to 10th input pulses respectively.

Two reset lines are provided; they are normally connected to the -6V line. The counter is set to the zero-condition when the 'Reset 0' line (TP'E') is momentarily raised more positive than +4V*; it isset to the five-condition when the 'Reset 5' line (TP'F') is momentarily raised more positive than +4V*.

* With respect to TP'C'

Gate, Control and Reset Circuit type 66/602 (Drg. ES66/T)

Gate-control Circuit:-

This circuit comprises binaries VT4-5 and VT6-7, in inter-lock connection, and inhibit-transistor VT14 which is normally held non-conductive by the inhibit signal circuit (VT10-11) treated later in this section. Gate control signals are produced at TP11**, i.e. the output of the second binary.

Both binaries are reset to the 0-condition (i.e. VT4 & VT6 conductive) upon receipt of a positive 'reset pulse' at the junction R9-R16; generation of this pulse is treated later.

The first negative-going signal received at Start Input TP12 triggers binary VT4-VT5 which in turn triggers binary VT6-VT7: both binaries are thus triggered to the 1-condition. The Gate Control output swings from the 'gate-closed-level' (approx. +5.5V*) to the 'gate-open level' (approx. 0V*).

The second binary (VT6-7) is triggered back to the 0-condition upon receipt of the next negative-going signal at Stop Input TP10; the output at TP11 therefore reverts to the 'gate-closed level'.

Henceforth the binaries are insensitive to further signals via TP10 and TP12 until they have been reset. Transistor VT14 is held conductive by the 'inhibit signal' (which is initiated coincident with the reset signal) and ensures that the binaries cannot again be triggered (to open the main signal gate; treated below) until after associated counter circuits have been reset.

Signal Gate:-

This circuit contains VT1-3 & VT16. Control signals from TP11 are received at control input TP16.

** TP = Termination point
* Voltage level with respect to TP3

The signals, passed via high input-impedance buffer amplifier/inverter VT1, operate control transistor VT2 of the transistor AND-gate comprising VT2-VT3. The gate is open (i.e. VT2 conductive) while TP16 is held at approximately 0V*; for this period (or gating time) signals received at TP14 pass via emitter follower VT16 and the a.c-coupled gate, and are hence presented inverted at output TP13.

Print Command Pulse (P.C.P.) & Display Time Circuit:-

The negative-going potential change produced at VT1-collector (to close gate VT2-VT3) is available at TP15 as a 'print command signal' for the control of data logging equipment: it also passes via C12 and triggers display time monostable VT8-VT9. The monostable remains in the new condition (VT8-VT9 cut-off) for the display time which is dependent upon the time constant C13 x (R25 + R26 + external resistance between TP9 & TP3). At the end of this period the circuit reverts to the stable state; a negative-going pulse is passed via C14, and C13 is charged linearly by VT8 collector current.

The latter occurs providing that no potential is applied to 'hold input' TP4; however, with VT9-collector connected via R29 and TP8 to the +6V* supply line, monostable VT8-VT9 cannot be triggered via C12. Therefore, to initiate reset action it is necessary to operate the following circuit (normally triggered via C14) by means of a push-button as described below.

Inhibit & Reset Circuits:-

These circuits incorporate transistors VT10 to VT13. The negative pulse received via C14 triggers 'inhibit monostable' VT10-VT11, whereupon Inhibit Output TP7 swings from approximately 0V* to the

* Voltage level with respect to TP3.

'inhibit level', i.e. more positive than +2.5V*, due to the action of emitter follower VT15. (In general this output is used to inhibit the normal operation of certain remote circuits until they have been reset, thus undesirable transient circuit-conditions are prevented. The signal produced at VT10-collector also operates VT14 treated above).

The monostable may also be triggered by a negative-going signal received via terminal point TP4.

As the monostable is triggered (i.e. as VT10 is cut-off and VT11 conducts) a negative-going signal is delivered, via C20, to VT12 and causes a positive 'reset pulse' to be produced at output TP5 (pulse width approx. 0.2ms): the pulse resets gate control binaries VT4-5 and VT6-7. The duration of the 'inhibit signal' is approximately 20ms (dependent upon time constant C16 x R31: this provides sufficient time for display-time-monostable capacitor C13 to be completely re-charged); the inhibit monostable then reverts to the stable state.

The inhibit monostable may be triggered manually. Depression of a normally open push-button connected between TP6 and TP2 presents a positive-going trigger pulse (via C19) to VT11-base and initiates the generation of both the inhibit and reset pulses: capacitor C18 serves as contact bounce suppressor for the remote push-button.

The particular reset-pulse-output-circuit of VT12-VT13 is employed to provide the necessary impedances between reset output TP5 and the +6V and -6V lines (at TP2 & TP1 respectively). In the normal condition, to maintain the reset lines of remote circuits connected to TP5 (e.g. decade counters) at the appropriate level, approx. -5.5V*, a low impedance path (provided by VT12: normally conductive) is required

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* With respect to TP3

between TP5 and the -6V line; whilst a high impedance (provided by R41: VT13 being non-conductive) is required between TP5 and the +6V line. However, during the reset period a low impedance output to the +6V line is required to raise the potential of the reset line to a sufficiently high value for the resetting of decade units etc: this is provided by the emitter follower action of VT13.

Decade Divider type 66/140 (Drg. ES66/36)

The decade comprises four bi-stables (e.g. VT1-2; VT3-4, etc) and is in the zero condition when transistors VT2, 4, 6 & 7 are conductive. The circuit is triggered by negative-going input signals applied to TP15 and operation is in 1-2-4-8 code.

The table below indicates the state of the decade for each count condition.

(N.B.For the respective bi-stables, 'o' represents conduction by VT2,4,6 & 7)
(" " " " '1' " " " VT1,3,5 & 8)

Bi-stable:-	VT1-2	VT3-4	VT5-6	VT7-8
Condition 0 :	o	o	o	o
" I :	1	o	o	o
" 2 :	o	1	o	o
" 3 :	1	1	o	o
" 4 :	o	o	1	o
" 5 :	1	o	1	o
" 6 :	o	1	1	o
" 7 :	1	1	1	o
" 8 :	o	o	o	1
" 9 :	1	o	o	1

Between count conditions 0 and 9, whenever the first bi-stable is triggered from '1' to 'o' a negative-going trigger signal is passed to the next bi-stable; the action is the same for the second and third bi-stables. When the fourth bi-stable is triggered from 'o'

to '1' diode MR10, previously reverse-biased, then serves to close diode-resistor gate R9-MR9 & 10. Therefore no trigger signal passes to the second bi-stable at the count transition nine to zero; but the final bi-stable (which is in the '1' state at count condition 9) is triggered to '0' by the negative-going signal produced at VT2 collector and passed via C16. As the decade thus reverts to the zero count condition, a negative-going 'output signal' is produced at TP13** (VT7 collector).

Three reset lines are provided. The 'Reset 0' line (TP5) and 'Reset 9' line (TP6) are necessary since opposite states of the first and fourth bi-stables are required to represent the respective count conditions 0 and 9. The remaining bi-stables (2nd & 3rd) are required in the same state for both conditions and are connected to the line marked 'Reset' (TP4).

The reset lines are normally held at -6V*. The decade is set to zero when the 'Reset' and 'Reset 0' lines are momentarily raised more positive than +4V*; it is set to 9 when the 'Reset' and 'Reset 9' lines are momentarily raised more positive than +4V*.

** TP = Termination point

* With respect to TP3

Circuit Description - - -

Double Decade type 66/100 (Drg. ES66/29)

In this circuit VT1-8 form the first decade and VT9-16 the second. Since the two decades are identical except for the termination point numbers used for the respective inputs and outputs (these are indicated on the left of diagram ES66/29) circuit description will be confined to the first decade.

The decade comprises four bi-stables (e.g. VT1-2; VT3-4,etc) and is in the zero condition when transistors VT2,4,6 & 7 are conductive. The circuit is triggered by negative-going input signals applied to TP15 and operation is in 1-2-4-8 code.

The table below indicates the state of the decade for each count condition.

(N.B. For the respective bi-stables, 'o' represents conduction by VT2,4,6 & 7)
" " " " '1' " " " VT1,3,5 & 8)

Bi-stable:-		VT1-2	VT3-4	VT5-6	VT7-8
Condition	0 :	o	o	o	o
"	I :	1	o	o	o
"	2 :	o	1	o	o
"	3 :	1	1	o	o
"	4 :	o	o	1	o
"	5 :	1	o	1	o
"	6 :	o	1	1	o
"	7 :	1	1	1	o
"	8 :	o	o	o	1
"	9 :	1	o	o	1

Between count conditions 0 and 9, whenever the first bi-stable is triggered from '1' to 'o' a negative-going trigger-signal is

passed to the next bi-stable; the action is the same for the second and third bi-stables. When the fourth bi-stable is triggered from 'o' to '1' diode MR18, previously reverse-biased, then serves to close diode-resistor gate MR17,18-R9. Therefore no trigger signal passes to the second bi-stable at the count transition nine to zero; but the final bi-stable (which is in the '1' state at count condition 9) is triggered to 'o' by the negative-going signal produced at VT2 collector and passed via C16. As the decade thus reverts to the zero count condition, a negative-going 'output signal' is produced at TP13** (VT7 collector).

Three reset lines (common to both decades) are provided. The 'Reset O' line (TP5) and 'Reset 9' line (TP6) are necessary since opposite states of the first and fourth bi-stables are required to represent the respective count conditions O and 9. The remaining bi-stables (2nd & 3rd) are required in the same state for both conditions and are connected to the line marked 'Reset' (TP4).

The reset lines are normally held at -6V*. The decade is set to zero when the 'Reset' and 'Reset O' lines are momentarily raised more positive than +4V*; it is set to 9 when the 'Reset' and 'Reset 9' lines are momentarily raised more positive than +4V*.

**TP = Termination point

* With respect to TP3

Pulse Shaper type 66/3C1 (Drg. (E)8/09)

Complementary emitter followers VT1 & VT3 operate with constant current source VT2 (current approx. 1mA determined by ratio R4:R5) and present a high input impedance to signals received at TP16*. Components MR1 and MR2 function as clamping diodes in the event of excessive input amplitudes: R2 and MR3 contribute to temperature compensation, whilst R6-C2 and R10-C4 & 5 with R27-C10 provide decoupling at the +6V and -6V supply lines respectively.

Signals produced at VT3 emitter pass via RV2 wiper and MR5 to the d.c.-coupled cascade amplifier comprising VT6 (of long-tailed-pair VT6-VT7) and VT5. De-coupling is provided by R16-C7 and R22-C9. The amplifier output from VT5 collector is passed via emitter follower VT8: d.c. feedback is applied to the input circuit via R18 and emitter follower VT4.

The long-tailed-pair is balanced by adjustment of RV1 and RV2, treated at the end of this description.

Signals from VT8 operate Schmitt trigger stage VT9-VT10 (VT9 normally conductive, VT10 non-conductive). The output of the Schmitt trigger, or shaper, is applied via capacitor C12 to pulse amplifier/ inverter VT11 at whose collector (TP6) a positive output pulse is produced as the shaper is triggered.

The latter pulse is also applied, via R37, to inverter VT13 which provides the inverted or negative pulse at TP8. This occurs providing input TP5 is held at the 'non-inhibit' level (i.e. approx. 0V**). Should TP5 be held at the 'inhibit level' (i.e. more positive than +2.5V**) VT12 conducts to hold VT13-base at approx. 0V and the negative pulse is therefore not produced at TP8.

Separate 0V supply lines are provided (at TP3 & 4 and TP13 & 14) so that the 0V line of the input emitter follower and associated amplifier may be separately earthed at the signal input socket of the instrument in which the

* TP = Termination point
** With respect to TP3 & 4

pulse shaper is employed: thus noise currents at the input of the stage are separately earthed.

Replacement of R2:

The required value of R2, which is selected during test, is dependent upon the gain of the particular transistors used in positions VT1 and VT2. Therefore should either transistor be changed (i.e. because of a fault condition) the following procedure should be carried out.

Note When the board is used in an instrument, to gain access to its preset controls, the instrument top-cover should be removed, and the board raised clear of the instrument by mounting it on an extension connector (Venner Part No.X50999/1).

i. Set Supply switch** of instrument to 'OFF' and ensure that the stage is receiving no input signals.

ii. Remove wire link between Pins B and C shown on circuit diagram E68/9.

iii. Remove resistor R2; then temporarily connect a 100kohm potentiometer, set to approx. mid-track, between Pins D and E.

iv. Three d.c. voltmeters (numbered 1, 2, 3 for reference) are required*; connect these as follows:-

Voltmeter - 1: between terminal point 16 (meter positive) and terminal points 13 & 14 (meter negative).

Voltmeter - 2: between Pin B (meter negative) and Pin C (meter positive).

Voltmeter - 3: between VT5-collector (meter negative) and VT7-collector (meter positive).

v. Switch ON supply to instrument and set its Sensitivity control to the 'maximum' position.

vi. Adjust 100kohm potentiometer for 0V indication on voltmeter - 1

vii. Adjust control RV1 for 0V indication on voltmeter - 3 and control RV2 for 0V indication on voltmeter - 2

* e.g. 'AVO' Model 8 set to the 10V d.c. range.
** In some instruments this is ganged to the Sensitivity control.

viii. Since the functions of RV1, RV2 and the 100kohm potentiometer will be to some extent inter-dependent, it may be necessary to re-adjust the controls referred to in vi & vii several times before OV is indicated concurrently by all voltmeters.

ix. Remove voltmeters 2 & 3. Reconnect one meter (as voltmeter - 4) between Pin A (meter positive) and terminal points 13 & 14 (meter negative). The indication given by voltmeter - 4 should lie between 2.65V and 3.15V. (when R30 = 150Ω)*.

x. Voltmeter - 1 should still indicate OV (if not, repeat method from procedure vi onwards).

xi. Switch instrument supply to 'OFF' and remove voltmeter - 4

xii. Without altering its setting, carefully remove the 100kohm potentiometer and measure the resistance between its two terminals just disconnected. Select a high stability ±1% (¼W) resistor of value just measured (or use ±1% H.S. resistors in parallel to give this value) and solder it between Pins D & E.

xiii. Switch ON supply and reset Sensitivity control to 'Max'. Check that voltmeter - 1 indicates OV: if voltage is not zero it is probable that the value of the substituted resistor is slightly incorrect; the general procedure should therefore be repeated.

xiv. Set Supply switch to 'OFF' then resolder link between pins B & C.

Adjustment of Preset Potentiometers RV1 & RV2

Should the settings of RV1 and RV2 be inadvertently altered, reset these controls by carrying out certain procedures given under 'Replacement of R2' as indicated below.

i & ii

iv: but connect only voltmeters 2 & 3

v & vii

viii: but ignore reference to 100kohm potentiometer and to vi.

ix & xiv.

* or between 2.55V and 2.85V when R30 = 100Ω. See Components List CL66/301.

Oscillators types 66/510, 66/511 & 66/512 (Drg. ES66/24)

Oscillator:-

A crystal controlled sinewave oscillator is formed by the circuit containing VT7 and VT8. On circuit boards type 66/510 trimmer C14 is preset for the required oscillator frequency whilst control RV1 is preset for maximum distortion-free output at TP8**

Components in the region marked 'B' on diagram ES66/24 are not fitted on circuit boards types 66/511 and 66/512; instead, the crystal (which is then normally housed in a thermostatically controlled oven) and the trimmer capacitor are mounted adjacent to the board and connected between TP6 and TP7.

Pulse Shaper & Inhibit Circuit:-

Signals applied to TP10 (normally the oscillator output or signals from an external frequency source) pass via inverter/amplifier VT6 to Schmitt trigger pulse shaper VT3-VT4.

Rectangular pulses, at the input frequency, occur at pulse shaper output TP13 providing an 'inhibit signal' is not present at TP12.

The inhibit input is normally held at approximately 0V* (inhibit off). However, to prevent shaper output pulses from passing to external counter circuits during the reset period, the inhibit level (more positive than +2.5V*) is applied to TP12: transistor VT5 therefore conducts to hold VT3 collector (TP13) at approximately chassis-earth potential.

** TP = Termination point

* Voltage level with respect to TP3.

Frequency Divider:-

The circuit shown in the region marked 'A' on diagram ES66/24 is basically that of a binary and is incorporated only in oscillators type 66/512.

The junction R8-MR3 of the binary is not connected to the -6V rail (TP1) but is available as a 'command signal' input at TP14. This input is held at -6V when the circuit is required to operate as a frequency divider, in which case negative-going signals from the preceding pulse shaper (i.e. from VT3 collector) pass alternately via C1-MR1 (to cut-off VT1) and C4-MR4 (to cut-off VT2) and trigger the binary. Square-wave signals of frequency half that of the shaper output are therefore produced at binary output TP16 and at complementary output TP15.

If frequency division is not required, command input TP14 is held at +6V. In this case MR3 and VT2 are normally conductive; transistors VT2 and VT1 operate as cascade-connected inverter/amplifiers for negative pulses produced at VT3-collector and passed via C4.

Store Transfer, Overflow & Delay Output (Drg.E66/80)

Delay Pulse Gating Indication & Store Transfer Pulse Circuits

The leading-edge of a negative-going gate control signal received at TP12 causes VT5 to conduct; its collector potential, normally held negative by potential divider R14 - R16, then swings positive causing VT15 (of complementary output pair VT15-16) to turn-off and VT14 to turn-on thereby giving rise to the positive-going edge of a Delay pulse at TP13.

Conduction by VT5 also causes VT6 to switch-on so that VT6 collector current may flow in a gating indicator neon tube connected between TP14 & TP15 and supplied via a potential divider R15, R19 from a +250V rail at TP16.

Upon receipt of the trailing-edge of the gate control signal at TP12, VT5 & VT14 turn-off and VT15 is turned-on to produce the negative-going trailing-edge of the delay pulse at TP13 whilst VT6 is turned-off to extinguish the external gating indicator lamp connected at TP14.

The gate control signal is fed via C1 so that upon receipt of the trailing-edge a positive pulse is presented to the anode of MR1 which gives rise to a negative-going pulse at the collector of inverter/amplifer VT1. The latter pulse serves to trigger the monostable circuit of VT2-VT3 which employs VT4 as output amplifier and is designed to produce a positive pulse of width approx. 200μs at TP11.

Overflow, Binary Store & Overflow Indication Circuits

These circuits comprise overflow (or master) binary VT7-VT8 and store (or slave) binary VT9-VT10 in control of VT11 which serves as a current switch for an external overflow indication neon lamp connected between TP7 & TP15.

For purpose of description it will be assumed that the store binary is in the non-overflow condition i.e. VT10 'ON' and VT9 (& VT11) 'OFF' with the overflow binary in the reset '0' condition (i.e. VT7 'ON' VT8 'OFF'). Should a negative-going carry pulse* be received at TP9 the binary is triggered to the 1-condition to register the occurrence of overflow.

With the slave binary control input (TP8) held at approx. -6V diodes MR6 & MR9 are held reverse-biased (irrespective of the condition of the master binary). TP8 may be externally connected to TP11 whereupon the latter condition will be held while the 'store transfer' pulse is not present; when TP8 is taken to +6V (or the leading-edge of the store transfer pulse occurs) MR6 remains cut-off(since VT7 collector is held at approx. 5V in the 1-condition of the master binary) but MR7 conducts so that the slave binary is triggered to the 1-condition whereupon VT11 conducts for illumination of an external overflow indication lamp.

When the trailing-edge of a transfer pulse occurs (i.e. when TP8 returns to approx. -6V) diodes MR6 & MR9 are again reverse biased to effectively disconnect the slave binary from the master binary which is reset to zero upon receipt of a positive pulse at reset zero input TP10.

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* Normally such a signal is produced at an output of an external counter as its count capacity is exceeded.

Gate VT16 & Control bistable VT(12 - 13):-

With the bistable in the reset (i.e. '0') condition, VT13 is cut-off whilst VT12 conducts so that its collector potential (approx.0V) holds the gate (VT16) cut-off. Signals presented to the gate input TP4 are then unable to pass to the output TP5.

Upon receipt of a negative-going start pulse at TP6 the binary is triggered to the 1-condition: the collector potential at VT12 therefore tends to that of +6V rail so that the gate emitter follower may conduct. Upon receipt of a negative-going pulse at gate input TP4 diode MR10 conducts to cut-off the gate, therefore a train of such pulses received at TP4 is effectively passed by the gate and reproduced at TP5 for the duration of the 1-condition of the control binary.

Low Speed Counter with Store and Display type 55/110 (Drg. E66/38)

Note: logic levels referred to below are on positive convention: '1' =5V approx.
'0' =0V "

The Low Speed Counter comprises four binaries (BIN 1,2,3,4) and diode gates arranged to give a scale of 10 and to operate on negative-going pulse edges received at TP10. It can be set to the 'zero' state by application of a positive pulse to TP11.

The function of the diode gate MR31, 33 and R49 is to inhibit transfer of the output of BIN 1 to the input of BIN2 while VT19 is conducting; this results in the cycle of Counter states shown in the table below, which assumes an initial 'zero' state.

No. of i/p pulses	Collector logic levels			
	VT14	VT16	VT18	VT20
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1
10	0	0	0	0

The output at TP9 consists of a '1' level pulse of width equal to twice the input pulse period.

Each collector in the counter is connected to a corresponding input gate of a store binary (e.g. SLAVE 1), the state of which is set by the switching-on of its non-conducting transistor. This can only occur when both the associated counter collector and the store transfer line are at a '1' level. Thus application of a positive pulse to TP12 sets the store (SLAVES 1,2,3,4) to a state corresponding directly to that of the counter. The store will remain undisturbed by changes in the counter state until another '0' to '1' change occurs on the transfer line.

The diodes MR1 to 10 decode the store state in conjunction with the transistors VT1 to 10 which switch the cathodes of the numerical indicator tube V1.

The neon tube V2 is provided as an independent indicator illuminating when TP23 is connected to a low potential.

Circuit ES66/84 (TSA5545 Wiring Diagram)

Resistors		Venner Part No.
R1	33Ω	X50500/13
R2,3,24,25	47kΩ	" /89
R4,5	22kΩ	" /81
R6,7	100kΩ	X50501/1
R8,12,15	1kΩ	X50500/49
R10,11	470kΩ	X50501/17
R13	15kΩ	X50500/77
R14	2.2 kΩ	" /57
R16,19	680Ω	" /45
R17	10kΩ	" /73
R18	3.3kΩ	" /61
R20,21,22	470Ω	" /41
R23	4.7kΩ	" /65
Resistors Variable		
RV1,2	500kΩ	X20999/51
RV3,4	1kΩ	" /52
RV5*	500kΩ	" /53
Capacitors		
C1,3,6,7,11,12	0.068µF	X23914/36
C2,4	0.47µF	" /24
C5 (trimmer)	4-60pF	Z21135/5
C8	0.047µF	X23914/38
C9 (a-c)	0.1+0.005+0.005µF	Z26102
C13,16,17	0.1µF	X23914/27
C14	820pF	Y20641/2
C15	47pF	Y50509/4
C18	220pF	Y50509/8
Diodes**		
MR1,2,3,5,6,7,8,9	1N4009	X20639/31
MR4	BZY88/C6V2	" /37

* Ganged to switch SE

** Note: The instrument may be supplied fitted with the above or equivalent types of diodes.

Circuit ES66/84 (TSA5545 Wiring Diagram)

		Venner Part No.
Transistors		
VT1,2	15718/2	X20638/55
VT3	V405A	X20638/65
Fuse		
FS1	500mA	Z22867/2
Neon Indicators		
V1	Overflow Lamp	Z50398
V2	Gating Lamp	"
Switches		
SA (1-4)	Function Selector	Y50847
SB (1-4)	TimeUnits/Frequency Divider	"
SC (1-4)	'Start' Switch	"
SD (1-4)	'Stop' Switch	"
SE	Display Time*	X20999/53
SF	t/Freq. B	Z21090
SG	Contact Bounce Filter	Z27067/1
SH	Stored/Free	"
SJ	Supply Switch	Z21090
SK	'Reset' Pushbutton	Z50393
SL	'Start' Pushbutton	"
SM	'Stop' Pushbutton	"
SN	Edgewise Switch	Z50924
SP	Normal/Recycle	Z27067/1
Sockets		
SKTA	'+ve'	X20637/85
SKTB	Reset Input	"
SKTC	Pulse Reset	X20637/96
SKTD	'A' Input	"
SKTE	'B' Input	"
SKTF	Delay Output	"
SKTG	Stop Pulse	"
SKTH	Start Pulse	"

* Ganged to RV5

Sockets (continued)		Venner Part No.
SKTJ	'C' Input	X20637/96
SKTK	'D' Input	"
SKTL	Start Control	"
SKTM	2MHz Test	"
Crystal		
XTL1	2MHz Type 4444	Y20650/11
Inductance		
L1, 2	Mains Choke	Z50803
Terminal		
TP1	Chassis-earth terminal	Y51121

For Preset Counters with type number suffix Z:-

Data Logging Output Socket (36 pin)	X20637/80*

* Mating free plug:- Amphenol 57-30360; Venner Part No. Z20637/79

Ref: P2114:

8/1G,2E,3F,4E,5G,6F,7H,8A

Components List - CL 66/310
Sheet 1.

Circuit ES66/94 (Stop/Start Shapers type 66/310)

		Wenner Part No.
Resistors:		
R1,7,14,33,39,46	22kΩ	X50500/81
R2,27,3 , 35	1kΩ	Z51569/1
R 25,28, 57,60	1kΩ	X50500/49
R4,6,9,36.38,41	2.2kΩ	" /57
R5,37	47Ω	" /17
R8,40	820Ω	" /47
R10,16,42,48	120Ω	" /27
R11,17,18,21,43,49,50,53	10kΩ	" /73
R12,15,23,24,26,30,44, 47,55,56,58,62	560Ω	" /43
R13,45	2.7kΩ	" /59
R19,20,51,52	5.6kΩ	" /67
R22,54	47kΩ	" /89
R29,32,61,64	4.7kΩ	" /65
Resistors Variable:		
RV1,2	56kΩ	X20999/62
Capacitors:		
C1,12	0.47µF	X23914/24
C(2-5),10,11,(13-16),21,22	22pF	Y50509/2
C6,7,17,18	100pF	" /7
C8,19	56pF	" /5
C9,20	0.1µF	X23914/27
C23,24	1500pF	Y50509/15
Transistors:		
VT (1-22)	U15718/2	X20638/55
Diodes:		
MR(2-6),(8-12)	IN4009	X20639/31

Circuit ES66/78 (Decade Ring Counter type 66/132)

Resistors		Venner Part No.
R1	22kΩ	X50500/81
R2	470Ω	" /41
R3,4,5,7,8,10,13,15,16,20, 21,23,24,28,29,31,32,36,37, 39,40,44	2.2kΩ	X50500/57
R6,9,14,17,22,25,30,33,38, 41,80	1kΩ	" /49
R11,12,18,19,26,27,34,35, 42,43	8.2kΩ	X50500/71
R45-79	Unused	--
Capacitors		
C (1-10)	22pF	Y50505/2
C (11-20)	68pF	" /6
C21,22	0.047μF	X23914/38
Diodes*		
MR (1-10)	IN4009	X20639/31
Transistors		
VT1	V435	X20638/72
VT (2-11)	U15718/2	" /55

Ref:- P2111 : 1/10

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*Note: The stage may be supplied fitted with the above or equivalent types of diodes.

Components List - - -

Capacitors (continued)	Value	Description	Venner Part No.
C16	2.2µF (35V)	Electrolytic	Y22776/12
C17	33pF ±5%	Ceramic N560	Y50509/3
C18	0.047µF ±10%(250V)	Polyester	X23914/38
C19,22	0.01µF ±10%(250V)	"	" /34
C20	0.022µF ±10%(250V)	"	" /37
C21	1000pF ±10%	Ceramic(High K)	Y50509/11

Diodes	Type	
MR(1-4),6,7	U2973/2	X20639/31/P
MR5	1N4009	" /41/P

Transistors		
VT (1-8),(10-16)	U15718/2	X20638/55
VT9	V435	" /72

Note: VT4 and VT5 to be matched pair
VT6 and VT7 " " " "

VT12 to have current gain of over 70

Ref:- P2109: 2/1 I/2B

Note: The stage may be supplied fitted with the above or equivalent types of components.

Components List - CL.66/140

Sheet 1

Decade Divider type 66/140 (Drg. ES66/36)

Resistors:		Venner Part No.
R1,8,9,10,17,18,25,26,33	3.3kΩ	X50500/61/P
R2,5,11,14,19,22,27,30	560Ω	" /43/P
R3,4,12,13,20,21,28,29	2.2kΩ	" /57/P
R6,7,15,16,23,24,31,32	10kΩ	"/73/P
Capacitors:		
C (1-16)	47pF	Y50509/4
Diodes:		
MR (1-10)	IS44 or BAY36	X20639/31/P
Transistors:		
VT (1-8)	BSY38	X20638/59

Ref:- P2073: 1/1-

Power Supply type 66/210 (Drg. E66/98)

Resistors:	Value	Venner Part No.
R1	470kΩ ±5% ¼W	X50501/17/P
R2	330Ω " "	X50500/37/P
R3	3Ω ±10% 3W	Z21092/3
R4	820Ω ±5% ¼W	X50500/47/P
R5	2.2kΩ " "	" /57/P
R6	0.5Ω ±10% 3W	Z21092/6
R7	1kΩ ±5% ¼W	X50500/49/P
R(8-10)	1.5kΩ " "	" /53/P
R11	270Ω " "	" /35
Resistors Variable:		
RV1,2	1kΩ ±20% ¼W	X20999/58
Capacitors:		
C1	8µF (350V)	Y20643/50
C2	0.1µF (400V)	X23914/45
C3	4000µF (25V)	X20643/51
C4	1250µF (25V)	" /52
C5,6	120µF (16V)	Y50506/10
C7,8	1000pF ±10%	Y50509/11
C9,10	15µF (20V)	Y22776/20
Diodes:		
MR1	BYX10	X20639/35/P
MR(2-5)	1N4001	" /45/P
MR6,7	BZY88/C4V7	" /33/P
Transistors:		
VT1	2N4037	X20638/82
VT2	V435	" /72
VT3,4	U15718/2	" /55
VT5	40250	" /60
Fuses:		
FS1	100mA	Z26413/1
FS2,3	1.5A	" /2
Transformer:		
T1		Y51043
Plug:	Type	
PLA	B9A	Z50402

Ref:- P2125: 3/1E/2D/3-

Note: The stage may be fitted with the above or equivalent types of components.

Components List - - -

Circuit E68/09 (Pulse Shaper type 66/301)

Resistors:	Value	Venner Part No.
R1	68kΩ ±5% ¼W	X50500/93/P
R2	Selected*	--
R3,36,41	470Ω ±5% ¼W	X50500/41/P
R4	8.2kΩ ±2% ¼W H.S.	X50502/24/P
R5	15kΩ " " "	" /26/P
R6,(10-12),17,23,42	100Ω ±5% ¼W	X50500/25/P
R7	1.8kΩ " "	" /55/P
R8,35	1.2kΩ " "	" /51/P
R9,13,37	2.7kΩ " "	" /59/P
R14	27kΩ ±2% ¼W H.S.	X50502/62/P
R15	4.7kΩ ±5% ¼W	X50500/65/P
R16	220Ω " "	" /33/P
R18	43kΩ ±2% ¼W H.S.	X50502/66/P
R19,20	2.2kΩ ±5% ¼W	X50500/57/P
R21	33Ω " "	" /13/P
R22	330Ω " "	" /37/P
R24	5.6kΩ " "	" /67/P
R25,28	390Ω " "	" /39/P
R26	270Ω " "	" /35/P
R27	10Ω " "	" /1/P
R29	1kΩ " "	" /49/P
R30	100Ω " "	" /25/P
or	150Ω** " "	" /29/P
R31	1.5kΩ " "	" /77/P
R32	680Ω " "	" /45/P
R33	560Ω " "	" /43/P
R38	3.3kΩ " "	" /61/P
R39	22kΩ " "	" /81/P

Resistors Variable:		
RV1	1kΩ ±20% ¼W	X20999/58
RV2	1kΩ ±10% 1W	" /78

* Value within range approx. 50kΩ to 150kΩ

** Preferred value 100Ω

Capacitors	Value	Venner Part No.
C1	47pF ±5%	Y50509/4
C2,4,8	33µF (10V)	Y22776/13
C3,12	22pF ±10%	Y50509/2
C5,15	1000pF ±10%	Y50509/11
C6,7,9,10	82µF (6.3V)	Y50506/4
C11	10pF ±5%	Y50509/1
C14	0.1µF ±10% (250V)	X23914/27

Diodes	Type	Venner Part No.
MR(1-4), (6-8)	U2973/2	X20639/31/P
MR5	BZY88/C5V6*	" /54/P
MR9	1N4009	" /41/P

Transistors		
VT1,(5-10),12,13	U15718/2	X20638/55
VT2,4	BC108	" /71
VT3,11	V405A	" /65

Note:

The current gain (OC') of transistors in this stage should be as indicated below: colours relate to the Venner transistor-colour-spot code which is also given.

VT1 : Pink/Green (or higher gain group)
VT2,3,4 : Pink (or higher gain group)
VT5,13 : Any colour/s (but not mixed gain groups)
VT(6-10) : Pink or higher gain groups (but not mixed)
VT11,12 : Any colour/s

Code:

Colour-spot(s)	:	Gain Group
Red	:	28-40
Yellow	:	41-50
Green	:	51-60
White	:	61-70
Pink	:	71-90

Colour spot(s)	::	Gain Group
Pink/Yellow	:	91 - 110
Pink/Green	:	111 - 150
Pink/White	:	151 - 170
Pink/White/White	:	Over 170

Ref: P2195:1A; 2B

* Specially selected and available under the Venner Part Number quoted

Circuit ES66/24 (Oscillators types 66/510, 66/511 & 66/512)

Resistors		Venner Part No.
R1,3,4,7,12	2.2kΩ	X50500/57/P
R2,5,19	470Ω	" /41/P
R6,8,15,25	22kΩ	" /81/P
R9	8.2kΩ	" /71/P
R10	680Ω	" /45/P
R11,20	1kΩ	" /49/P
R13,28,32	10kΩ	" /73/P
R14,29	100Ω	" /25/P
R17,30	3.3kΩ	" /61/P
R18	5.6kΩ	" /67/P
R21	33kΩ	" /85/P
R22	150kΩ	X50501/5/P
R23	47kΩ	X50500/89/P
R24	330Ω	" /37/P
R26	68Ω	" /21/P
R27	15kΩ*	" /77/P
R31	27kΩ	" /83/P
R16	18kΩ	" /79/P
Resistors Variable		
RV1	5.6kΩ	X20999/55
Capacitors		
C(1-4)	47pF	Y50509/4
C5	56pF	" /5
C6	220pF	" /8
C7	15µF (20V)	Y22776/20
C8	22pF	Y50509/2
C9,11,17	0.1µF	Y23914/27
C10	0.0047µF	" /40
C12	1000pF**	" /41
C13	33pF	Y50509/3
C14	30pF (trimmer)	Z21135/6
C15	82pF	Y50509/6
C16	1000pF	" /11
C18	0.01µF	X23914/34

* On oscillator type 66/510 R27 = 10kΩ	X50500/73/P
** On oscillator type 66/511 C12 = 680pF	X23914/53

Transistors	Type	Venner Part No.
VT1,2	BSY38 or equivalent	X20638/59
VT3,4,8	BSY95A " "	" /56
VT5,7	BSY65 " "	" /70
VT6	BC108 " "	" /71
Diodes		
MR (1-5)	IS44 or equivalent	X20639/31/P
Crystal		
XL1	100kHz type MC	Y20650/10*

* Crystals specially selected and stocked under Venner Part No. Y20650 are fitted to oscillators marked 66/510/14.
Use of such oscillators is restricted to instruments type TSA6614.
(NB. Any one of the following crystals may be used as replacement in an oscillator fitted in a TSA6614:- Y20650/14
X20650/9
Y20650/10)

Ref: P2033: 2/1G/2B
P2077: 1.C
P2113: 1D

Circuit E66/80 (Store Transfer, Overflow & Delay Output type 66/610)

Resistors		Venner Part No.
R1,6,10,13,15,28,30,33,35,36	10kΩ	X50500/73
R2	560Ω	" /43
R3,20,22,26,41	6.8kΩ	" /69
R4,12,24,27	22kΩ	" /81
R5	2.2kΩ	" /57
R7,16,18,37	47kΩ	" /89
R8,9,14,21,25,40,44	1kΩ	" /49
R11,50	47Ω	" /17
R17,38	220kΩ	X50501/9
R19	150kΩ	" /5
R23,52	820Ω	X50500/47
R29,32	5.6kΩ	" /67
R31,34	100kΩ	X50501/1
R39	3.3kΩ	X50500/61
R42,45	4.7kΩ	" /65
R43,46	18kΩ	" /79
R47,48,49	22Ω	" /9
R51	220Ω	" /33
Capacitors		
C1	56pF	Y50509/5
C2	220pF	" /8
C3,5	22pF	" /2
C4	0.01μF	X23914/34
C6,9,10,11	47pF	X50509/4
C7,8	33pF	" /3

Diodes*		Venner Part No.
MR (1-12)	IN4009	X20639/31
Transistors		
VT1,2,3,(7-10),12,13,14,16	U15718/2	X20638/55
VT4,15	V435	" /72
VT5	V405A	" /65
VT6,11	C407	" /69

Note: The current gain ( ) of transistors in this stage should be so indicated; colours relate to the Venner transistor-colour-spot code given below.

VT1,5,14,16 : Pink (or higher gain group)
VT2,3, (7-10),12,13: Any gain group

Code:-

Colour-spot/s:	Gain Group	Colour-spot/s	: Gain Group
Red	: 24-40	Pink/Yellow	: 91-110
Yellow	: 41-50	Pink/Green	: 111-150
Green	: 51-60	Pink/White	: 151-170
White	: 61-70	Pink/White/White	: Over 170
Pink	: 71-90		

Ref:- P2115 : 2/1B/2-

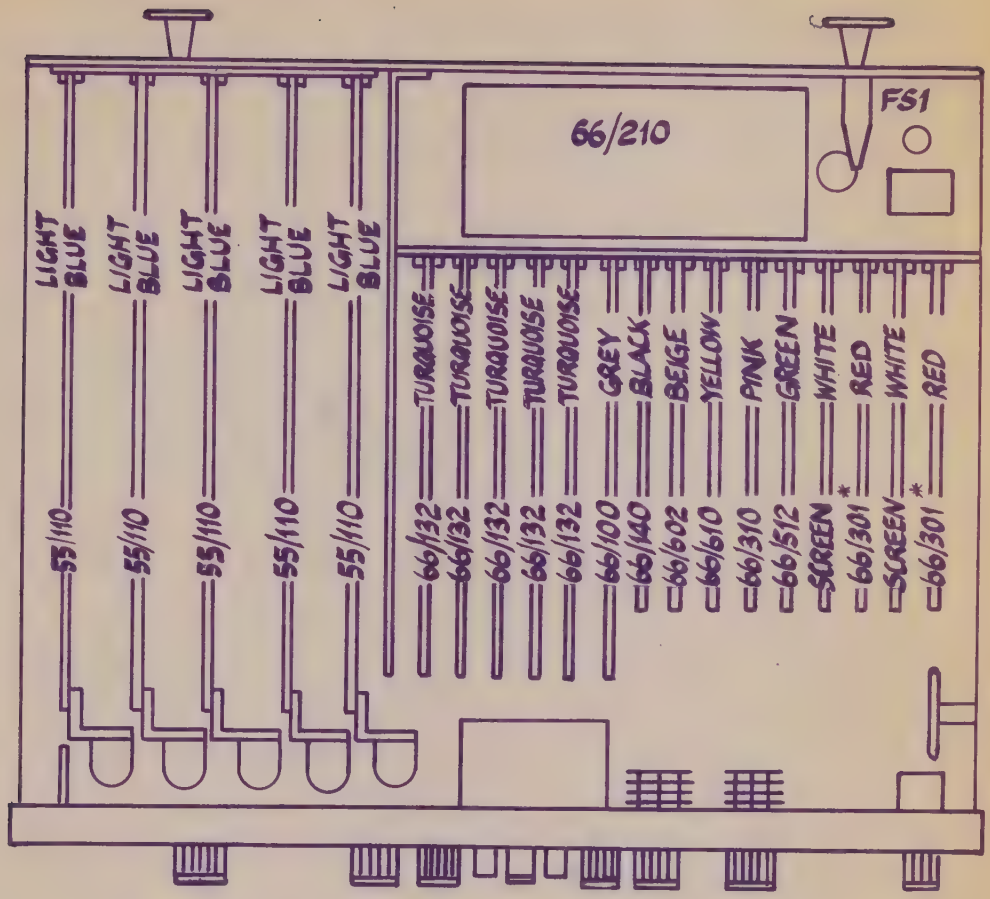
*Note: The stage may be supplied fitted with the above or equivalent types of diodes.

Components List CL55/110
Sheet 1.

Circuit E66/38 (Low Speed Counter with Store & Display type 55/110)

Resistors		Venner Part No.
R1,10	6.8kΩ	X50500/65
R2,6,12,16,22,26,32, 36,(97-100)	1kΩ	" /49
R3,7	3.9kΩ	" /63
R4,8	4.7kΩ	X50500/65/P
R5,9	47kΩ	X50503/5
R11,14,18,20,21,24,28,30, 31,34,38,40,(78-82)	10kΩ	X50500/73
R13,17,23,27,33,37	5.6kΩ	" /67
R15,19,25,29,35,39	100kΩ	X50501/1
R41,43,45,48,49,50,52,54, 57,58,60,62,65,66,69,71,74	2.2kΩ	X50500/57
R42,47,76,77	470Ω	" /41
R44,46,53,55,61,63,70,72	22kΩ	" /81
R51,56,59,64,68,73	680Ω	" /45
R67,75,(83-92),94	Unused	
R93	270kΩ	X50501/11
R96	470kΩ	" /17
R95	47kΩ	X50512/2
Capacitors		
C1,3,5,7,9,11	22pF	Y50509/2
C2,4,(13-15)	47pF	" /4
C6,8,10,12,16	33pF	" /3
C17,18	0.01µF	X23914/34
Transistors		
VT (1-10)	C407	X20638/69
VT (11-26)	U13718/2	" /55
Diodes		
MR (1-46)	1N4009	X20639/31
Neon Tubes		
V1	Nixie GR10M/U	Y50318/3
V2	Decimal point indicator	Z50398
Socket		
SKT A	13-pin valveholder	Z50482

Ref. P2043;



N.B. ONLY MAJOR COMPONENTS ARE SHOWN.

* OR TYPE 66/300.

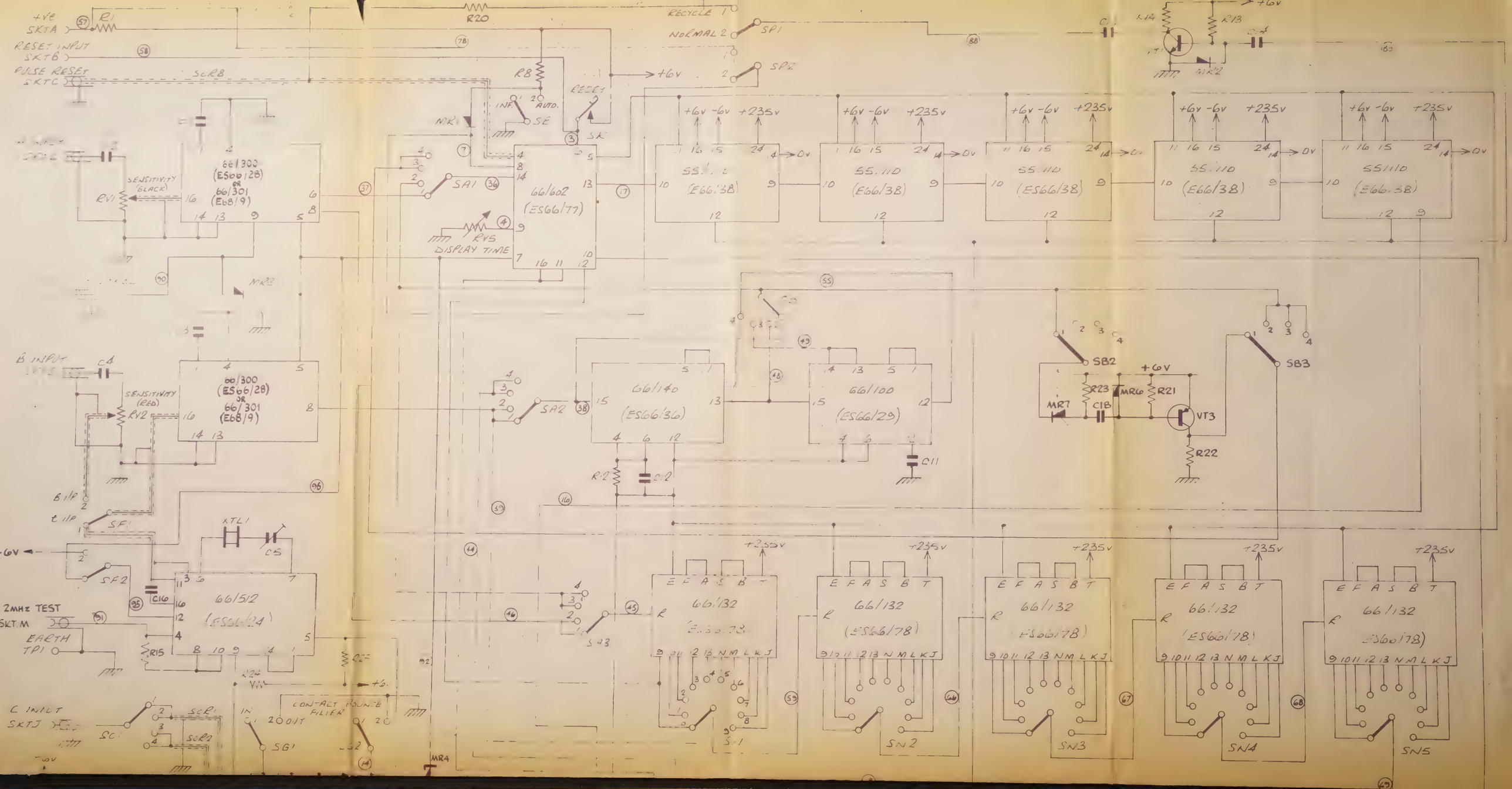
LAYOUT DIAGRAM

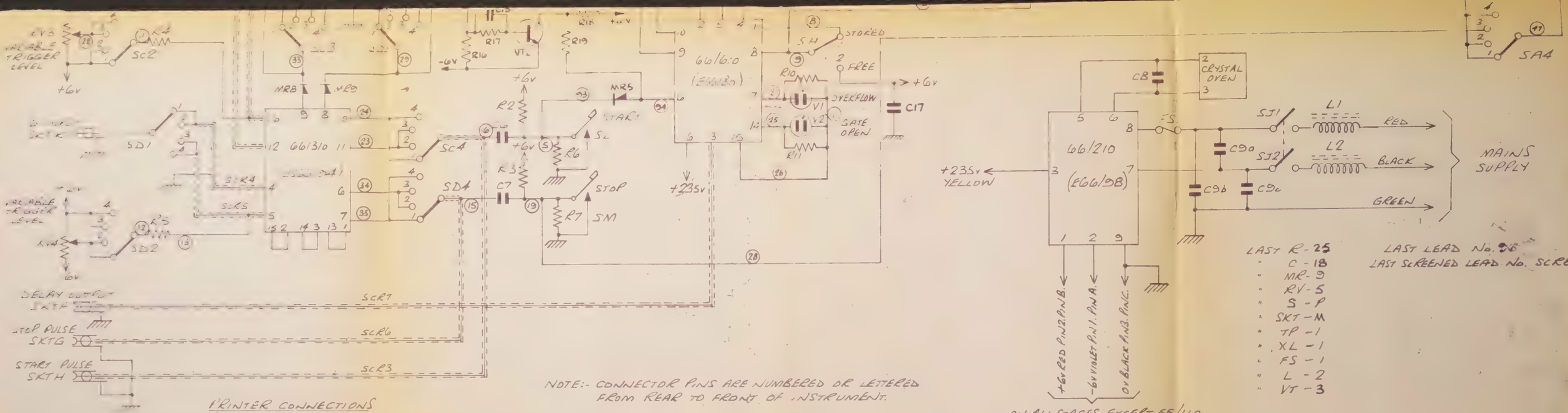
TSA 5545

S65/39

1

VENNER ELECTRONICS LTD


+ve SKTA
R1
RESET INPUT SKTB
PULSE RESET SKTC
SCRB
R20
RECYCLE 1
NORMAL 2
SP1
SP2
RB
+6v
RESET
INT.
AUTO.
SE
SK
MR1
SA1
RV5
DISPLAY TIME
66/602 (ES66/77)
66/300 (ES66/28) OR 66/301 (E68/9)
SENSITIVITY (BLACK)
RV1
MR2
B INPUT
C4
SENSITIVITY (RED)
RV2
B I/P
t I/P
SF1
XTL1
C5
-6V
SF2
C16
66/512 (ES66/24)
2MHz TEST
SKT.M
EARTH
TP1
R15
22Ω
C17
+6v
C INHIBIT
SKTJ
SCR1
SC1
SCR2
IN
200Ω
CONTACT BOUNCE FILTER
SG1
SG2
MR4
+6v -6v +235v
55.110 (E66/38)
SA2
66/140 (ES66/36)
R12
0.2
66/100 (ES66/29)
C11
SB2
SB3
R23
C18
MR6
R21
MR7
VT3
R22
66/132 (ES66/73)
66/132 (ES66/78)
SN1
SN2
SN3
SN4
SN5



NOTE:- CONNECTOR PINS ARE NUMBERED OR LETTERED FROM REAR TO FRONT OF INSTRUMENT.

ON ALL STAGES EXCEPT 55/110

LAST R-25
" C-18
" MR-9
" RV-5
" S-P
" SKT-M
" TP-1
" XL-1
" FS-1
" L-2
" VT-3

LAST LEAD No. 36
LAST SCREENED LEAD No. SCR8

PRINTER CONNECTIONS

SOCKET A (0 = 0·5V, 1 = 4·5V)

PIN 1 – PIN 8 } M.S.D 55/110
" 2 – " 6
" 3 – " 4
" 4 – " 2
" 5 NOT USED
" 6 – PIN 8 } 2ND M.S.D 55/110
" 7 – " 6
" 8 – " 4
" 9 – " 2
" 10 NOT USED
" 11 – PIN 8 } 3RD M.S.D 55/110
" 12 – " 6
" 13 – " 4
" 14 – " 2
" 15 NOT USED
" 16 – PIN 8 } 4TH M.S.D. 55/110
" 17 – " 6
" 18 – " 4
" 19 – " 2

PIN 20 NOT USED
" 21 – PIN 8 } L.S.D. 55/110
" 22 – " 6
" 23 – " 4
" 24 – " 2
" 25 NOT USED
" 26 " "
" 27 " "
" 28 " "
" 29 " "
" 30 " "
" 31 " "
" 32 " "
" 33 – P.C.P. P.N.1S ON 66/602
" 34 – EARTH. (0V)
" 35 NOT USED
" 36 " "

SOCKET B (0 = 4·5V, 1 = 0·5V)

PIN 1 – PIN 7 } M.S.D 55/110
" 2 – " 5
" 3 – " 3
" 4 – " 1
" 5 NOT USED
" 6 – PIN 7 } 2ND M.S.D. 55/110
" 7 – " 5
" 8 – " 3
" 9 – " 1
" 10 NOT USED
" 11 – PIN 7 } 3RD. M.S.D 55/110
" 12 – " 5
" 13 – " 3
" 14 – " 1
" 15 NOT USED
" 16 – PIN 7 } 4TH M.S.D. 55/110
" 17 – " 5
" 18 – " 3
" 19 – " 1

PIN 20 NOT USED
" 21 – PIN 7 } L.S.D. 55/110
" 22 – " 5
" 23 – " 3
" 24 – " 1
" 25 NOT USED
" 26 " "
" 27 " "
" 28 " "
" 29 " "
" 30 " "
" 31 " "
" 32 " "
" 33 – P.C.P. P.N.1S ON 66/602
" 34 – EARTH (0V)
" 35 NOT USED
" 36 " "

4 LINE SOCKET A ONLY TSA 5545/2
4 " " B " TSA 5545/21
8 " " A & B TSA 5545/22

SB TIME UNITS t/B FREQUENCY DIVIDER

POSITION 1 – 1μS (PERIOD B x 1)
" 2 – 10μS (" B x 10)
" 3 – 100μS (" B x 10^2)
" 4 – 1mS (" B x 10^3)

SA FUNCTION SWITCH

POSITION 1 – FREQ A or t (RATIO nA/B)
" 2 – PERIOD n/At (RATIO nB/A)
" 3 – TIME C → D/n (COUNT B in C → D)
" 4 – DELAY C → nt (DELAY C → n/B)

SN DIVIDER SWITCH

SC START SWITCH

POSITION 1 – N/O
" 2 – N/C
" 3 – +
" 4 – –

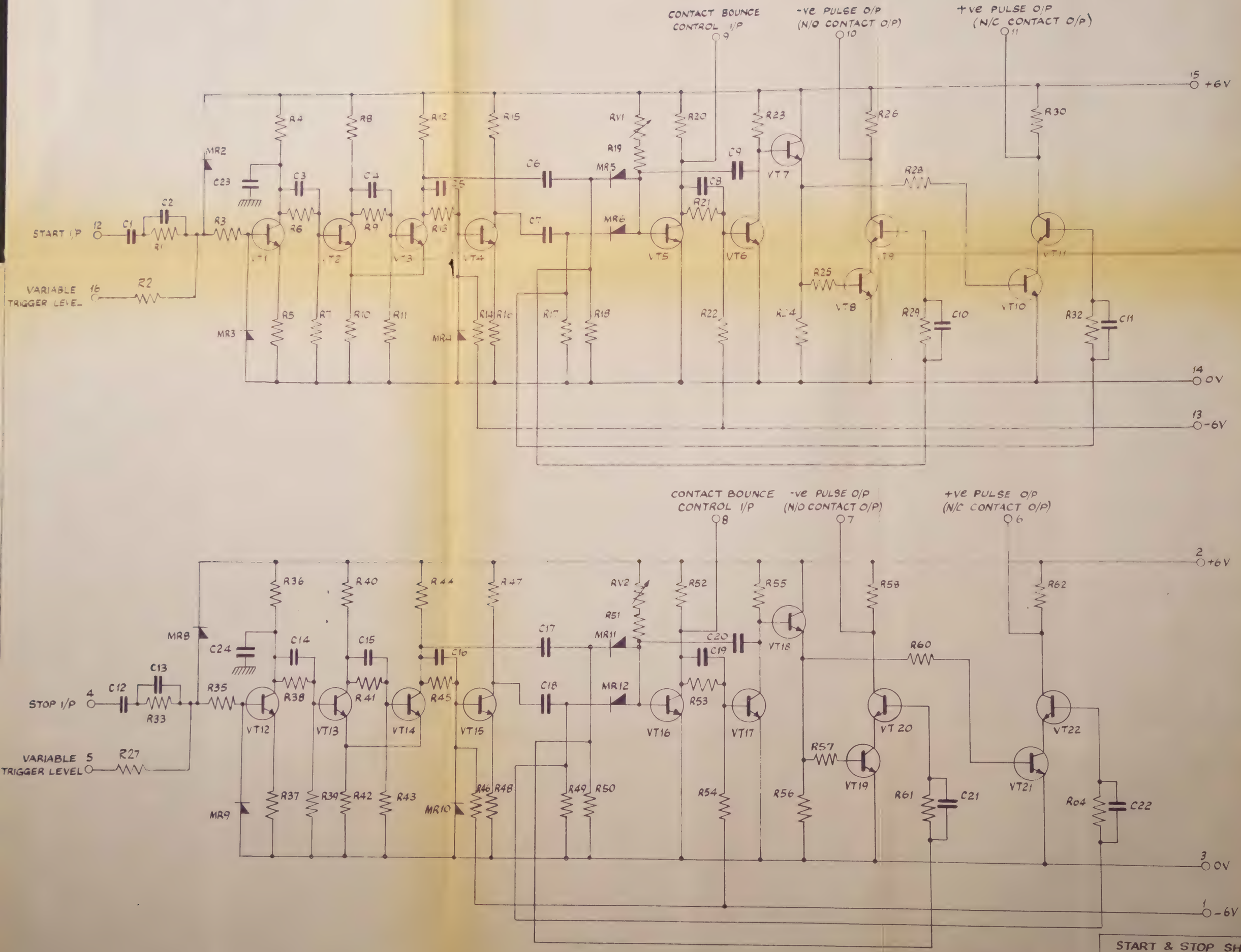
SD STOP SWITCH

POSITION 1 – –
" 2 – +
" 3 – N/C
" 4 – N/O

PRESET COUNTER
TSA 5545

ES66/84

VENNER ELECTRONICS LTD



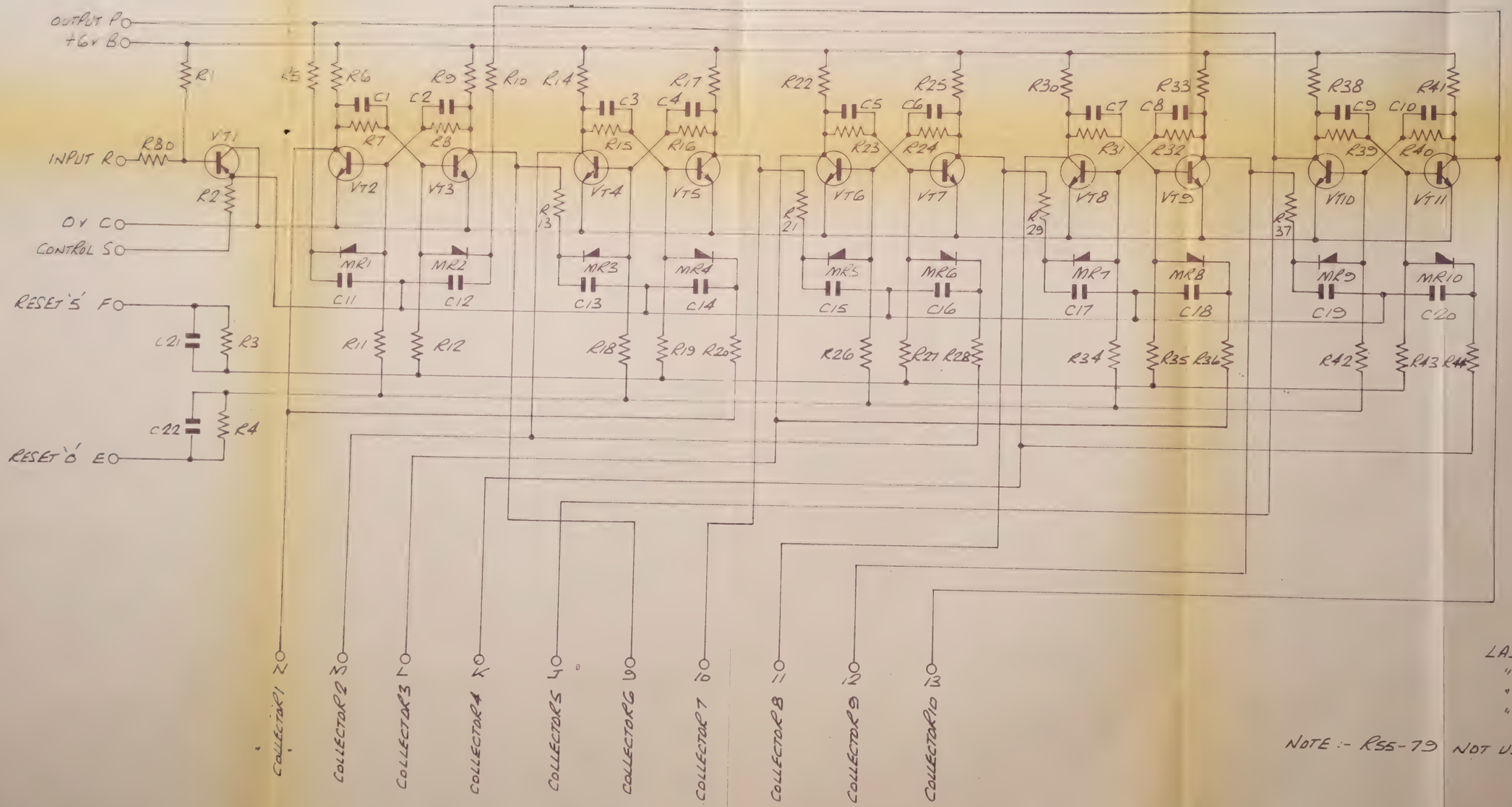
LAST R - 64
" C - 24
" MR - 12
" VT - 22
" RV - 2

R31, 34, 59, 63 NOT USED.
MR. 7 NOT USED

START & STOP SHAPERS
66/310

ES 66/94

VENNER ELECTRONICS LTD.



LAST R-80
" C-22
" VT-11
" MR-10

NOTE :- R55-79 NOT USED

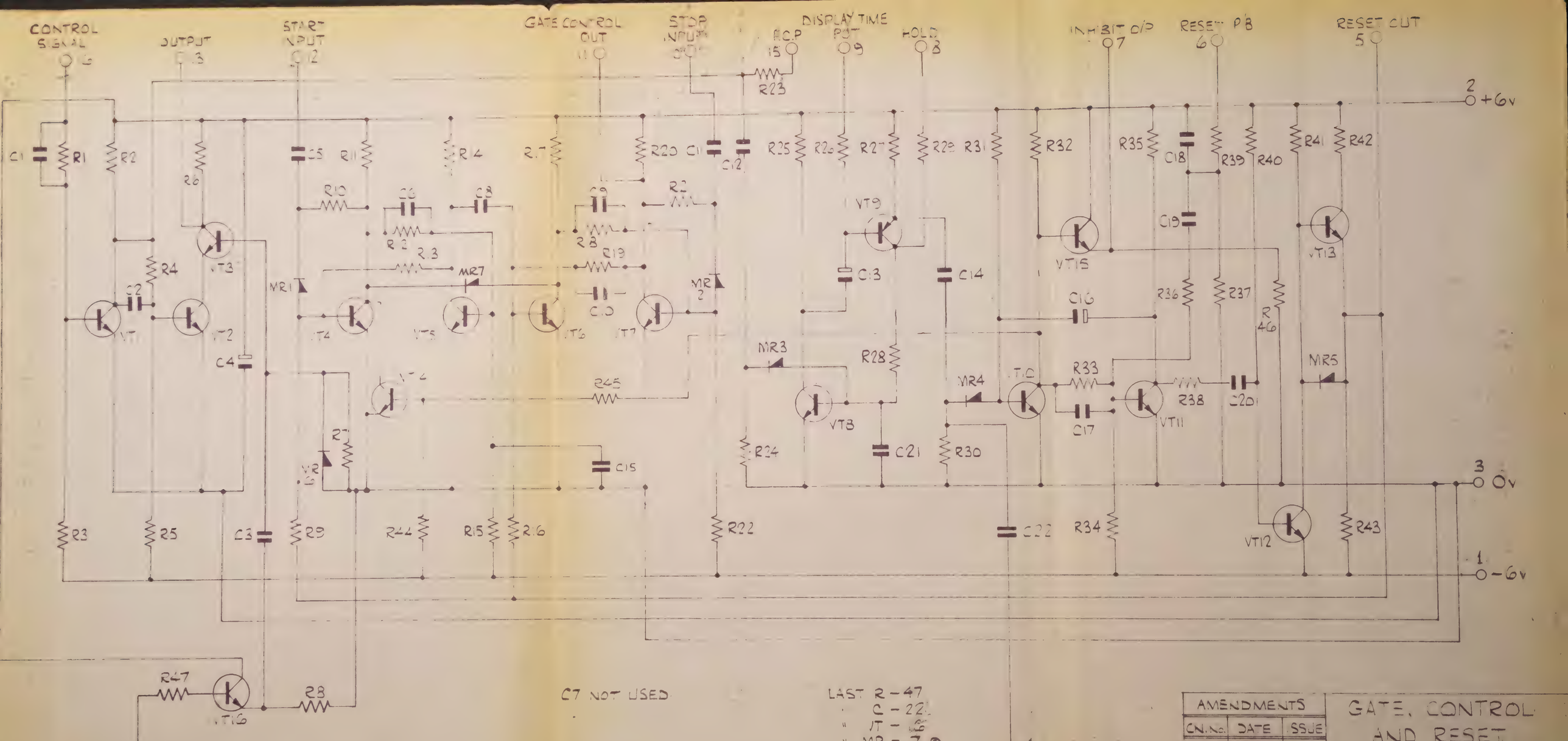
NOTE:- LETTERS G.I.O AND Q NOT USED ON CONNECTOR

LETTERED CONTACTS APPEAR ON COMPONENT SIDE
NUMBERED CONTACTS APPEAR ON REVERSE SIDE

DECADE RING COUNTER 66/132

ES66/78

VENNER ELECTRONICS LTD



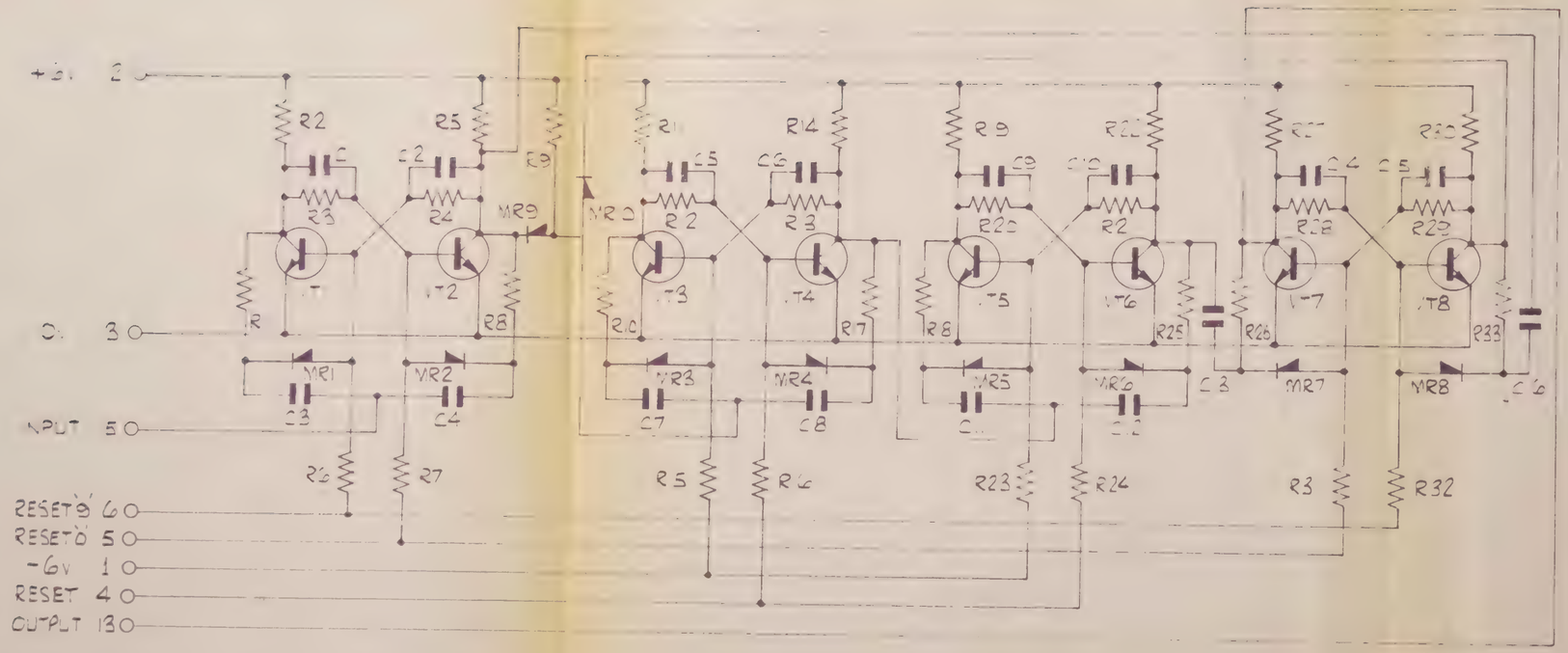
AMENDMENTS		
CN. No.	DATE	ISSUE
10179	28.3.68	A
S.D.	30.4.68	B
10306	31-10-68	C

GATE, CONTROL AND RESET
66/60?

DRAWN	T.C McCULLEY
CHECKED	
DATE	30-7-67

ES66/7?

VENNER ELECTRONICS LTD.



LAST R - 33
C - 6
VT - 8
MR - 0

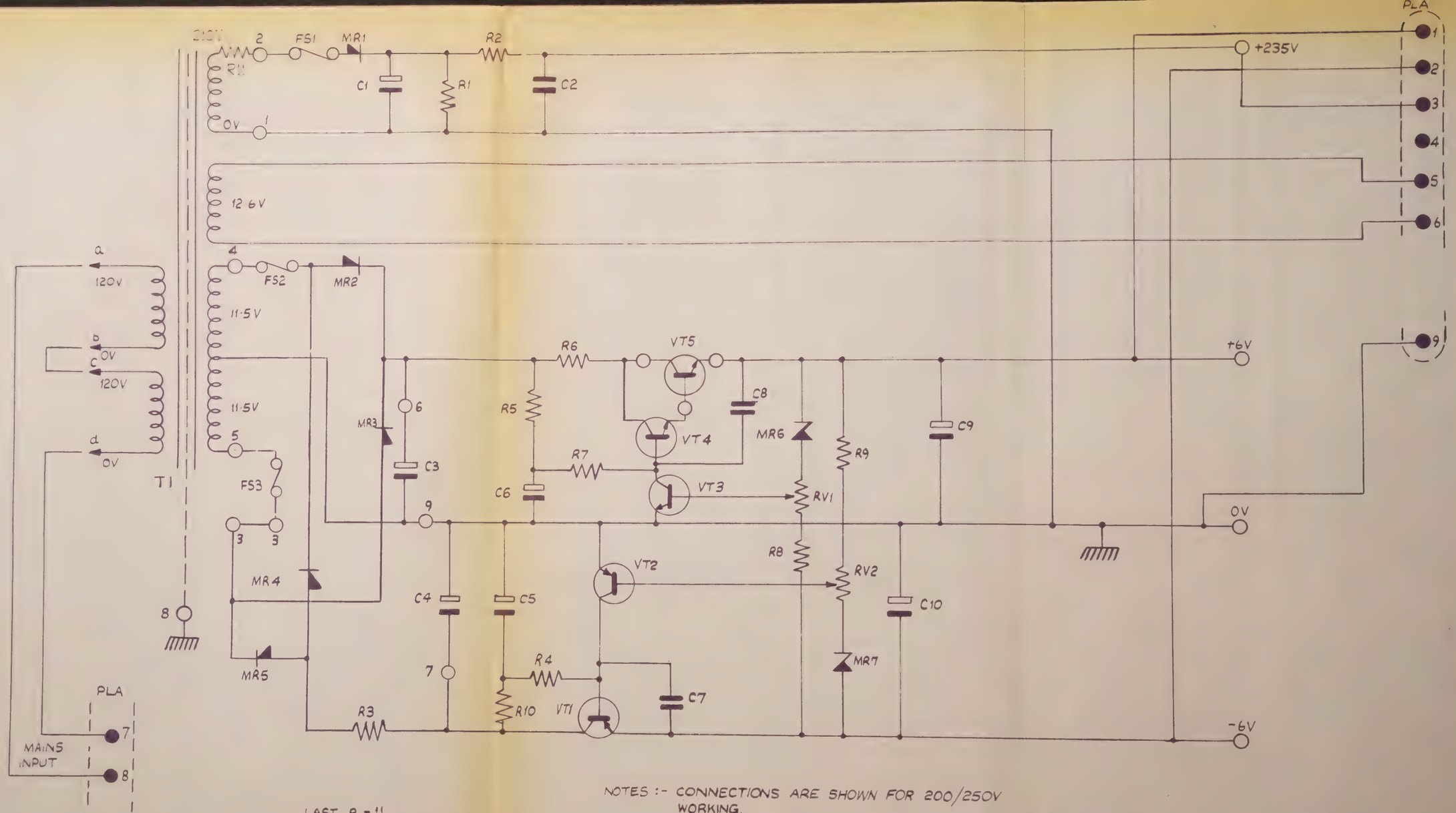
AMENDMENTS		
CN. No.	DATE	ISSUE

DECADE DIVIDER
66/40

DRAWN	T.C. McCULLEY
CHECKED	
DATE	17-12-66

ES66/36

VENNER ELECTRONICS LIMITED



LAST R - 11
" RV - 2
" C - 10
" MR - 7
" VT - 6
" FS - 3

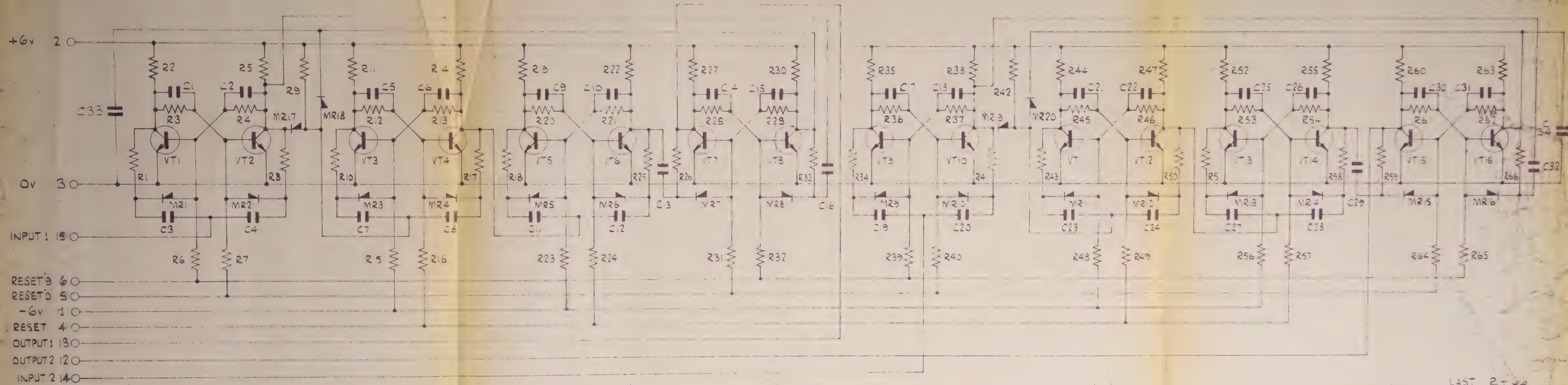
NOTES :- CONNECTIONS ARE SHOWN FOR 200/250V WORKING.
FOR 100/125V WORKING DISCONNECT LINK FROM b-c & CONNECT LINKS FROM a TO c AND b TO d.
TERMINATION POINTS ON THE PRINTED CIRCUIT BOARD ARE NUMBERED THUS —○ 2

DRAWN	S.R.M.
APPROVED	
DATE	11.68.

POWER SUPPLY
66/210

E66/98

VENNER ELECTRONICS LTD



LAST R-66
C-34
VT-16
MR-20

AMENDMENTS		
CN. NO	DATE	ISSUE
0111	23-5-67	A

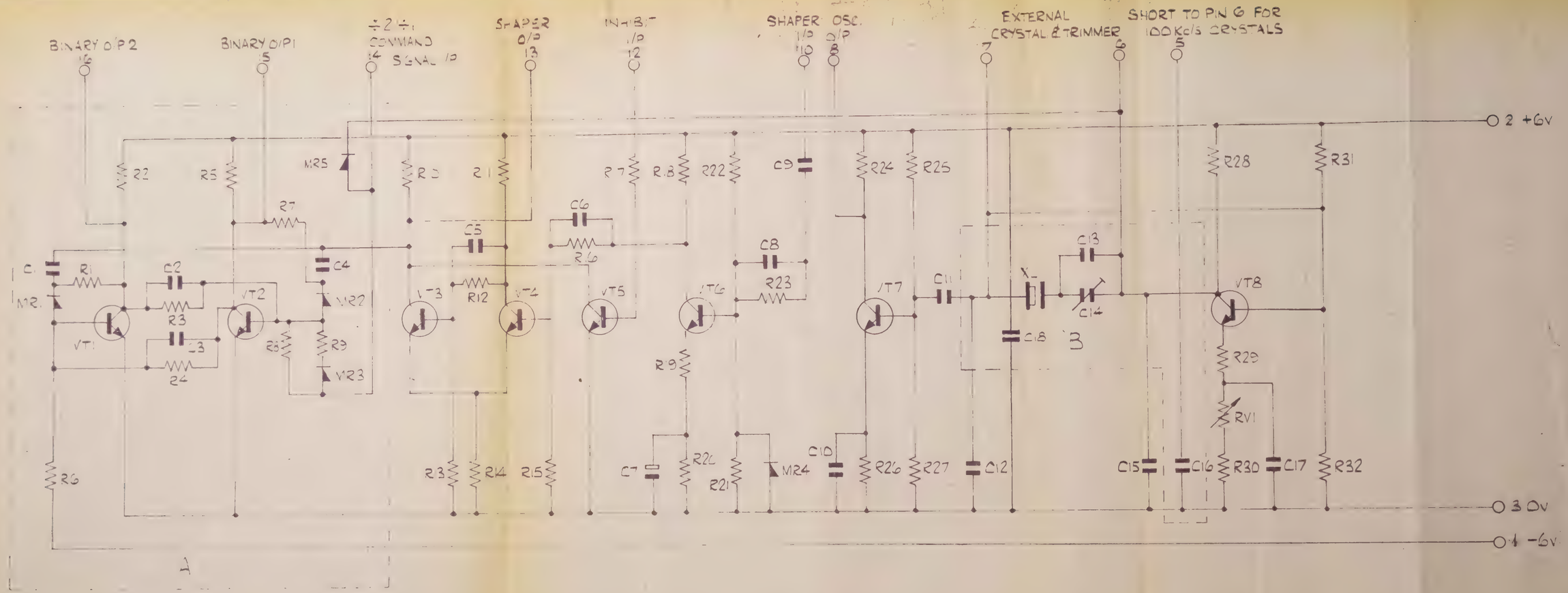
DOUBLE DECADE

66/100

DRAWN	T.C. McCULLEY
CHECKED	N. [illegible]
DATE	20-6-66

ES 2629

VENNER ELECTRONICS LTD.



NOTE:- FOR 66/5.. OMIT 'A' & 'B'

FOR 66/5.2 OMIT 'B'

FOR 66/510 OMIT 'A'

LAST R-32
C-18
MR-5
VT-8
XTL-1
RV-1

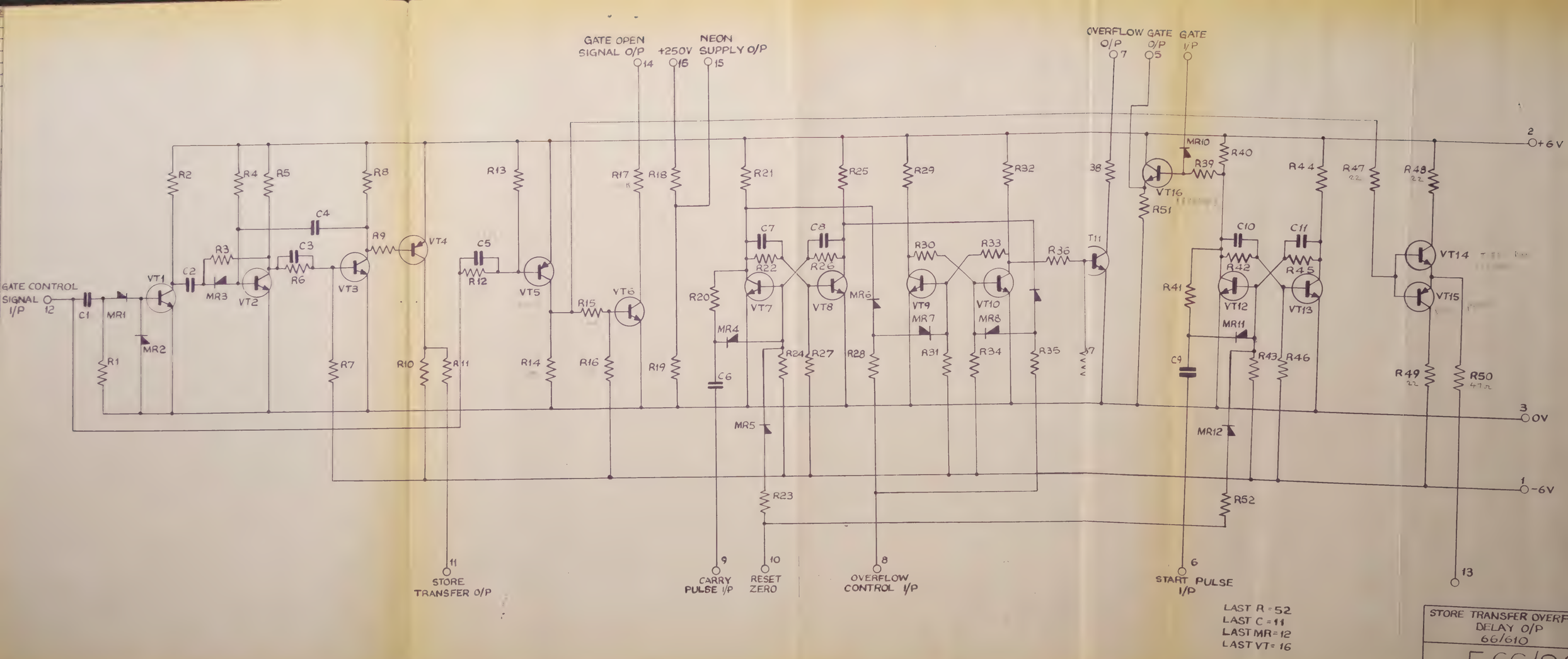
AMENDMENTS		
CN No.	DATE	ISSUE
10533	6-1-70	A
10572	20-3-70	B

OSCILLATOR
66/510, 66/511, 66/512

DRAWN	T.G.McCULLEY
CHECKED	
DATE	26-8-66

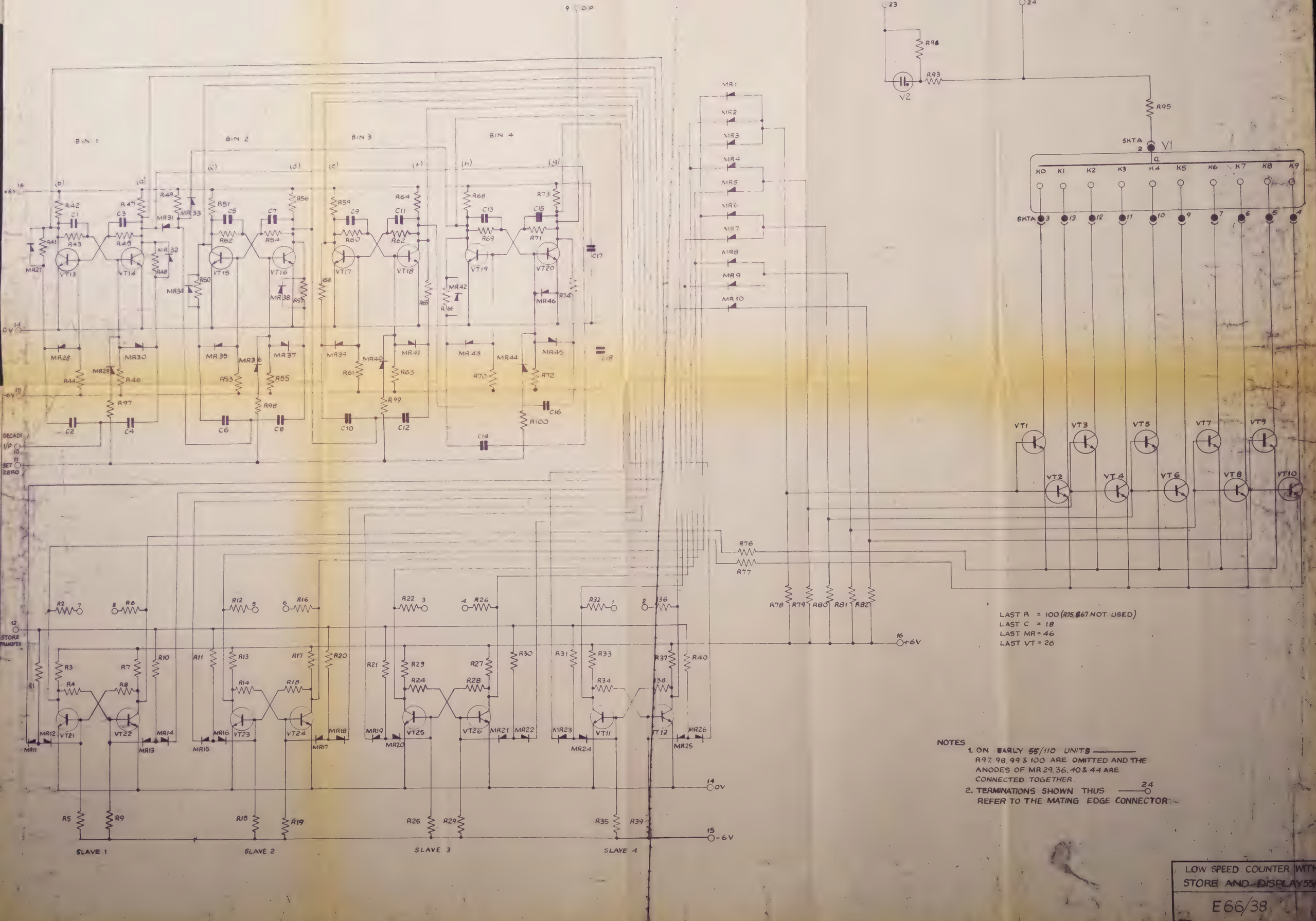
ES66/24

VENNER ELECTRONICS LIMITED



LAST R = 52
LAST C = 11
LAST MR = 12
LAST VT = 16

STORE TRANSFER OVERFLOW & DELAY O/P 66/610
E 66/80
VENNER ELECTRONICS LTD


BIN 1
BIN 2
BIN 3
BIN 4
+6V
0V
-6V
DECADE I/P
SET ZERO
STORE TRANSFER
SLAVE 1
SLAVE 2
SLAVE 3
SLAVE 4
+250V
V1
V2
SKTA
SKTB
K0 K1 K2 K3 K4 K5 K6 K7 K8 K9
VT1 VT2 VT3 VT4 VT5 VT6 VT7 VT8 VT9 VT10
MR1 MR2 MR3 MR4 MR5 MR6 MR7 MR8 MR9 MR10
LAST R = 100 (R75, R67 NOT USED)
LAST C = 18
LAST MR = 46
LAST VT = 26
NOTES
1. ON EARLY 55/110 UNITS — R97, 98, 99 & 100 ARE OMITTED AND THE ANODES OF MR 29, 36, 40 & 44 ARE CONNECTED TOGETHER.
2. TERMINATIONS SHOWN THUS —24 REFER TO THE MATING EDGE CONNECTOR.
LOW SPEED COUNTER WITH STORE AND DISPLAY 55/110
E66/38
VENNER ELECTRONICS LTD

Pulse Shaper type 66/300 (Drg. ES66/28)

Complementary emitter followers VT1 & VT3 operate with constant current source VT2 (current approx. 1mA determined by ratio R4:R5) and present a high input impedance to signals received at TP16*. Components MR1 and MR2 function as clamping diodes in the event of excessive input amplitudes: R2 and MR3 contribute to temperature compensation, whilst R6-C2 and R10-C4 & 5 with R27-C10 provide de-coupling at the +6V and -6V supply lines respectively.

Signals produced at VT3 emitter pass to the d.c.-coupled cascade amplifier comprising VT6 (of long-tailed-pair VT6-VT7) and VT5. De-coupling is provided by R16-C7 and R22-C9. The amplifier output from VT5 collector is passed via emitter follower VT8: d.c.-feedback is applied to the input circuit via R18 and emitter follower VT4.

The long-tailed-pair is balanced by use of RV1: adjustment of the control is treated at the end of this description.

Signals from VT8 operate Schmitt trigger stage VT9-VT10 (VT9 normally conductive, VT10 non-conductive). The output of the Schmitt trigger, or shaper, is applied via differentiating circuit C12-R34 to pulse amplifier/inverter VT11 at whose collector (TP6) a positive output pulse is produced as the shaper is triggered.

The latter pulse is also applied, via C13-R37, to inverter VT13 which provides the inverted or negative pulse at TP8. This occurs providing input TP5 is held at the 'non-inhibit' level (i.e. approx. 0V**). Should TP5 be held at the 'inhibit level' (i.e. more positive than +2.5V**) VT12 conducts to hold VT13-base at approx. 0V and the negative pulse is therefore not produced at TP8.

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* TP = Termination point

** With respect to TP3 & 4

Circuit Description - - -

(vi) The second voltmeter should indicate OV; if necessary adjust RV1 for this value.

(vii) Since the setting of the 500kΩ potentiometer and that of RV1 will be to some extent inter-dependent, it may be necessary to re-adjust these two controls several times before the potentials referred to in procedures (i) and (vi) are present simultaneously.

(viii) Switch OFF the supply. Carefully remove the 500kΩ potentiometer (without altering its setting) and measure the resistance between its two terminals just disconnected. Select a high stability (¼W) resistor, of 'preferred value' nearest to the value just measured and connect it between Pins D & E.

(ix) Switch ON the supply. Readjust RV1 for OV indication on the second voltmeter. Check that the other voltmeter (i.e. connected to TP16) indicates OV (+0.2V, -OV).

Adjustment of Preset Potentiometer RV1

Should the setting of RV1 have been inadvertently altered, reset the control as follows.

(a) With the supply switched OFF connect a voltmeter as in procedure (iv) above.

(b) Set potentiometer RV1 to its clockwise limit.

(c) See Note in 'Replacement of R2' above: then switch ON the supply and with no input signals applied, turn RV1 slowly anti-clockwise until the voltmeter indicates OV.

Components List - - -

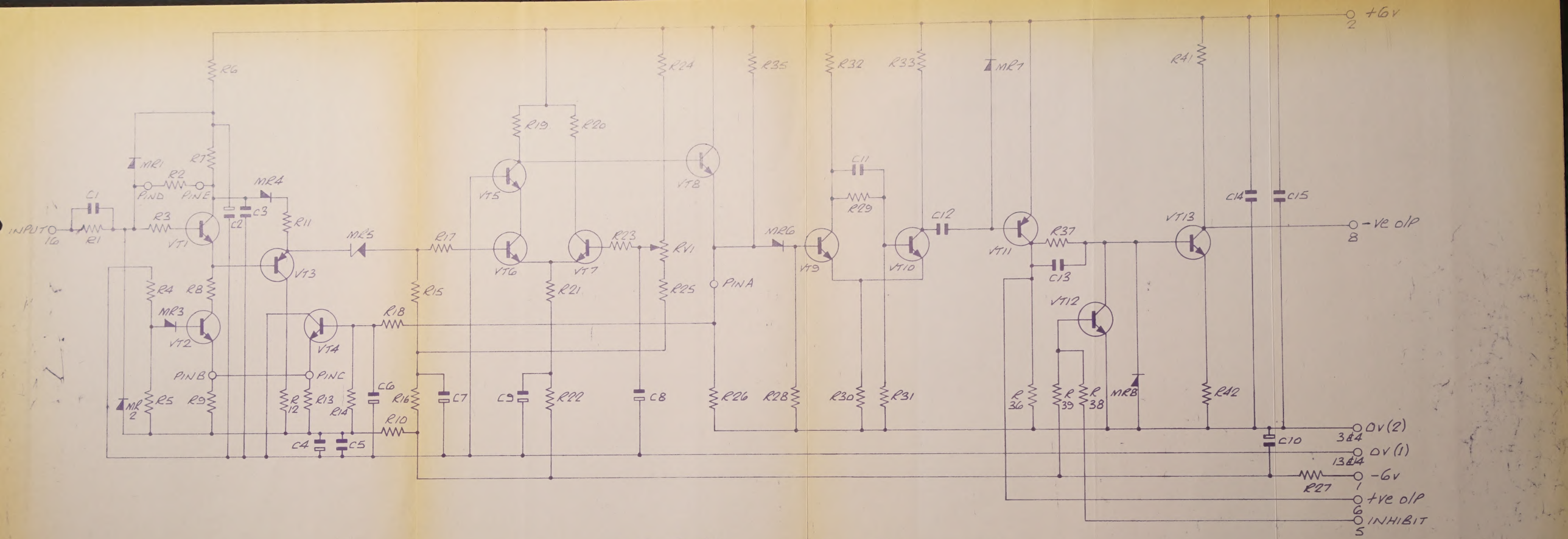
Capacitors: (continued)		Venner Part No.
C5,15	1000pF	Y50509/11
C 6,7,9,10	82µF	Y50506/4
C11, 3,12	22pF	Y50509/ 2
C1	47pF	" / 4
C14	0.1µF	X23914/27
Diodes:*		
MR (1-4), 7;8	IS44 or BAY36	X20639/31/P
MR5	BZY88/C5V6**	" /54
MR6	U2973	" /31/P
Transistors:*		
VT1,2,(4-10), 13 ,12	U15718/1 or U15718/2	X20638/55
VT3,11	V405A	" /65

Note: Venner transistor-gain code colours:-

VT1	:	Pink/Green (or greater)
VT2,5, 13	:	Any colour/s but not mixed
VT4,6,7,9,10	:	Pink (or greater but not mixed)
VT11,12	:	Any colour/s
VT3,8	:	Pink or greater

Ref:- P2037:
2/1J/2E

* The unit as supplied may be fitted with the above or equivalent types of transistors and diodes.
** Specially selected version available ur Venner Part No. quoted.



LAST R - 42
" C - 15
" MR - 8
" VT - 13
" RV - 1

R34 NOT USED
R40 " " "

AMENDMENTS		
CN.No.	DATE	ISSUE
10118	8·11·67	A
10157	10·2·68	B
10305	31·10·68	C

PULSE SHAPER
66/300

DRAWN	T.C. McCULLEY
CHECKED	
DATE	29·3·67

ES66/2

VENNER ELECTRONICS LTD.